AIR QUALITY GUIDELINES FOR ARENAS IN NOVA SCOTIA

The Recreation Facility Association of Nova Scotia would like to thank the following departments for their contribution to the development of the Air Quality Guidelines for Arenas in Nova Scotia

NS Health Promotion Sport and Recreation

NS Environment and Labour

COMMITTEE MEMBERS

- Bill Cruickshank - Recreation Facility Association of Nova Scotia
- Shelley Gray - Department of Labour
- Denis Huck – Halifax Regional Municipality
- Debbie Mason – Ringette Nova Scotia
- David Molloy – Nova Scotia Sport and Recreation Commission
- Brian Noiles – Sackville Sports Stadium
- Kim Peckford – Department of the Environment
- Robin Scott – Lunenburg Memorial Arena
- Kathie Wheadon-Hore – Dalhousie University

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ENDORSED BY

Nova Scotia Department of Health
Nova Scotia Department of Labour, Occupational Health & Safety
Nova Scotia Sport and Recreation Commission
Recreation Facility Association of Nova Scotia

FOREWORD

The guidelines presented in this manual have been developed through a number of sources throughout Canada. Their purpose is to address the quality of air in arena facilities in Nova Scotia.

These guidelines are considered to be the minimum standards necessary for safe arena operation. Through reducing emissions at their source, and ensuring proper equipment operation and maintenance, ventilation and monitoring of indoor air levels, the arena operator will be better able to control arena air quality.

Arenas, by their nature, are generally cold, damp building in which an artificial environment is created for users to compete and recreate. It is also a place of business and, as such, owners and operators have a duty of care to ensure a safe environment for all users and staff. **Therefore, owners and operators may be found liable for injury if the proper environment is not maintained.**

The scope of these guidelines is limited to carbon monoxide and nitrogen dioxide. This document does not address other contaminants that may exist in arenas, such as ammonia or CFC's.

These guidelines do not supersede or circumvent any existing or pending legislation within the Province of Nova Scotia.

We sincerely hope, through the implementation of the suggested guidelines and operational recommendations that the air quality in Nova Scotia arenas will be conducive to safe participation for everyone.

INTRODUCTION

The Issue

Since the mid 1980's, arena personnel have identified a rising number of incidents related to poor air quality, with participants experiencing varying degrees of illness and difficulty in physical function. Research reveals that air quality problems are linked to a number of sources and that remedial action is necessary.

Several types of combustion processes contribute to indoor air quality. The major products of combustion are carbon dioxide and water vapor, but other contaminants are also introduced into the environment. Of the numerous by-products of combustion, contributors to indoor air contamination are carbon monoxide, the oxides of nitrogen and respirable suspended particles (RSP). The relative amount of each of these contaminants depends upon the fuel burned and the conditions of burning.

Indoor combustion sources (**including gasoline and propane)** tend to be intermittent and generally confined to certain areas of the structure. As a result, levels of combustion by-products in indoor air vary with use patterns, and vary from room to room within a structure. They may also vary with outdoor conditions. This variability must be taken into account when monitoring indoor air for combustion by-products.

Two major sources of the poor air quality for arenas are the ice resurfacer and edger. Air tests in Canadian arenas have shown that there is often too much nitrogen dioxide and carbon monoxide gas in the air immediately after the ice has been cleaned and flooded. In sufficient concentrations, carbon monoxide and nitrogen dioxide are very dangerous, if not deadly.

There are three groups of concern with respect to exposure – the arena operators, the participants and the spectators. The arena operators spend 8 hours or more in the arena. Participants can spend from one hour to several hours in the facility depending on the activity. **The health effects of carbon monoxide and nitrogen dioxide are thought to be more pronounced if the person is: physically active in the arena, very young, very old, or has pulmonary, heart or asthmatic susceptibilities/disabilities.**

Carbon Monoxide

Carbon monoxide is a colourless, odourless, tasteless gas. It is a product of incomplete fuel combustion, and is produced in larger quantities by **gasoline and propane** than by diesel engines. Carbon monoxide reduces the oxygen carrying capacity of the blood.

Exposure to low levels of carbon monoxide (about 20 ppm) over an extended period (approximately 8 hours) is reported to result in absorption of sufficient amounts to cause

slight changes in temporal judgment or visual acuity. These changes are slight and unlikely to be noticed by the affected person. Pre-existing respiratory or circulatory ailments in individuals can be aggravated when levels increase above 30 ppm.

As carbon monoxide exposure increases above 50 ppm, headaches are reported more frequently. Depending on levels in excess of 50 ppm, and the duration of exposure, symptoms will progress from headaches and drowsiness to rapid breathing, nausea, and vomiting. Death can occur at extremely high levels (greater than 800 ppm).

Sources of carbon monoxide are: the ice resurfacer (gasoline or propane), ice edger, gasoline powered floor sweepers, lift trucks, improperly vented gas fired infrared radiant heaters, gas fired water heaters, special event equipment, and vehicles idling in the parking facilities in close proximity to the building.

Nitrogen Dioxide

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

You can detect nitrogen dioxide by odour at 5 ppm or below. At low levels of 0.4 ppm for 3 hours, mild asthmatics were shown to have increased airway reactivity with typical symptoms of cough, wheezing and shortness of breath. At moderate levels of 15 to 25 ppm, it can be irritating to the eyes, nose and throat. At higher levels, above 25 ppm, more severe symptoms can develop which include pneumonia or bronchiolitis. At these high concentrations, there are usually three stages of response.

In the first stage, coughing and irritation, irregular heartbeat, nausea and fatigue may occur but will subside once exposure stops. In the next stage, the person feels fine. The last stage occurs within 6-36 hours when the person may experience symptoms such as rapid breathing, chest pain and flu-like symptoms.

Depending on the severity of exposure, symptoms can progress to include inflammation of the lungs (pneumonitis) or accumulation of fluid in the lungs (pulmonary edema). Individuals with pre-existing respiratory system disorders, such as asthma, may be more sensitive to the effects of nitrogen dioxide.

Maximum Levels of Exposure

The following recommended maximum levels of exposure to carbon monoxide and nitrogen dioxide have been established based on a review of similar policies and legislation for recreational facilities in British Columbia, Saskatchewan and Ontario, research of air quality studies conducted in arenas, and air quality standards from government departments and national and international organizations.

1) **During every hour that the ice is used by the public, the average carbon monoxide level shall not exceed 25 parts per million (ppm). The average nitrogen dioxide level shall not exceed 1 ppm.**
    a. Levels above 25 ppm of carbon monoxide can affect vision and balance causing children to have serious accidents while skating.
    b. Levels above 1 ppm of nitrogen dioxide can result in increased breathing difficulty.
2) **During any 8 hour work period, no worker's exposure shall exceed an average of 25 ppm carbon monoxide or 0.2 ppm nitrogen dioxide.**
    a. A worker has the potential of being exposed to high levels of carbon monoxide and nitrogen dioxide when using ice edgers and other equipment. To prevent workers from becoming sick, any exposure to carbon monoxide above 25 ppm, or to nitrogen dioxide above 3 ppm must be balanced off. In other words, workers must spend enough time working at lower gas levels so that their total daily average exposure is less than 25 ppm of carbon monoxide and less than 0.2 ppm of nitrogen dioxide.
3) **Limits of 125 ppm of carbon monoxide shall not be exceeded at any time during the shift.**
    a. In addition, workers must not be exposed to over 75 ppm carbon monoxide for over 30 minutes and at no time should 125 ppm be exceeded, even when the average exposure for the day is below 25 ppm.

Important Note:
It is recommended that all facility staff become familiar with the symptoms associated with exposure to carbon monoxide and nitrogen dioxide (page 19). Early detection of an air quality problem may prevent a serious situation from occurring.

ESTABLISHING A PROGRAM

To protect everyone in an arena, it is imperative that a program be put in place that monitors, controls, and evaluates its air quality. Creating clean air involves a number of factors that, when implemented properly and continuously, will ensure a system is in place to provide the best environment.

A good air quality program involves:

- Control measures (substitution, modification and ventilation)
- Training
- Building design
- Monitoring
- Evaluation

Control Measures

The main sources of combustion gases in ice arenas are from self-propelled gasoline, propane or diesel driven ice resurfacing machines and ice edgers.

A safety barrier generally surrounds the ice in order to maintain the ice in uniform condition and to provide a measure of spectator safety when hockey is played. The barrier allows the creation of an inversion layer at a height of 4 to 8 feet above the ice, and within this layer there is practically no air movement. One of the reasons carbon monoxide exposures have occurred in ice arenas is that exhaust gases are trapped in this inversion layer and tend to remain relatively undiluted due to the lack of air movement.

A reduction in combustion product exposure can be achieved by several means, some of which are:

1. Elimination of known source of contaminants
    a. Replacement of existing, or the purchase of first time equipment which is not combustion powered would eliminate most problems involving combustion products in arenas. Although electrical resurfacers are now available they involve other special considerations. Of importance from the point of view of occupational exposure would be charging facilities and for many community arenas, the cost is nearly twice that of a propane or gas operated ice resurfacer.
2. Modification
    a. Extending the exhaust pipe from the engines to a height of at least one foot above the arena's safety barrier and discharging exhaust gas vertically upwards would enable the hot gases to rise and be diluted. The

exhaust pipe should be insulated to prevent burning the operator or anyone else who inadvertently comes in contact with it. The discharge should always be directed away from the operator while the equipment is mobile (i.e. the operator should not be breathing fumes while they are resurfacing the ice).

b. The addition of a catalytic converter on the engine's exhaust is one of the most effective means of reducing carbon monoxide. However, it is not recommended as the sole method because special procedures must be followed to maintain effectiveness, and failure may occur without warning. If a catalytic converter is to be effective, an engine warm up time of at least seven minutes is required, either in a well-ventilated area or exhausted directly outside.
c. A regular maintenance program with final engine tuning through carbon monoxide analysis of exhaust gases is essential to minimize carbon monoxide levels from gasoline and propane fueled equipment. Care must be taken when reducing carbon monoxide levels by carburetion adjustment to avoid a corresponding increase in relative amounts of nitrogen dioxide. Such a situation merely lends itself to a substitution of contaminants and potential health effects, with no resolution of the root problem. To prevent this from occurring, carbon monoxide concentration of exhaust gases should be limited to 1% for propane fueled machines, and 2% for gasoline fuelled machines in equipment without catalytic converters (a catalytic converter should further reduce this level below 1%). With respect to diesel fueled vehicles, nitrogen oxides are more of a problem than carbon monoxide and adjustments should be made to maintain low emissions for nitrogen dioxide and particulates.

3. Ventilation 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

Natural ventilation is provided by cracks, windows, 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.)

The ventilation rate required is that which will maintain the carbon monoxide and nitrogen dioxide concentrations within the recommended standards. There is much less 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 during resurfacing to help break up the inversion layer by increasing air movement.

b) FORCED MECHANICAL

With the construction of more airtight arenas, the need has arisen 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.

The amount of mechanical ventilation required depends on: the frequency of the resurfacing operations, air distribution, the combustion gases emitted from the equipment (usually carbon monoxide is used as a benchmark), the internal size of the arena, and whether the system will be used continuously or only during resurfacing hours.

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.

Training

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

- Use and maintenance of air quality monitoring equipment
- The recording of air quality data
- Use and maintenance of ice resurfacing equipment
- Ice maintenance practices
- Awareness of hazards and the symptoms associated with excessive exposure to carbon monoxide and nitrogen dioxide
- Emergency procedures with respect to high levels of carbon monoxide and nitrogen dioxide.

Building Design

It is recommended that during facility construction and/or renovation, consideration be given to:

- Ensuring adequate ventilation systems are in place
- The installation of air quality monitoring devices
- The air quality standards identified in this publication can be achieved or exceeded

The designing of adequate ventilation systems for arenas must consider both: (1) the need for adequate ventilation to minimize levels of toxic gases, and (2) the fact that large volumes of outside air may interfere with making and maintaining ice.

Monitoring

An effective air quality management program can be realized if proper monitoring is performed on a regular basis with accurate monitoring equipment and a well-trained, knowledgeable staff. It is recommended that:

- A schedule for air testing be put into place and adhered to
- Periodic calibration of the air monitoring equipment be performed as per the manufacturer's guidelines
- A review of the weekly measurements be done to determine if the implemented control measures are effective, and to determine if corrective action is necessary.

Evaluation

When evaluating an air quality program, it is recommended that:

- A detailed review be performed of the facility's air quality program to ensure that the standards set by the facility continue to be met
- Regular reviews of the procedures for air monitoring be conducted with the facility staff to identify areas for improvement
- Hold discussions with facility users on a regular basis to determine if an improvement in air quality is recognized, and/or to educate the users on the measures the facility has implemented for their safety.

DOCUMENTING A PROGRAM

Once an air quality program has been set up which maintains air quality standards, the program should be documented in writing. The written program shall be made available to all staff upon request.

The amount of pollution which equipment produces and the effectiveness of ventilation systems can change. Therefore, test the air daily: selecting times when equipment is being used heavily. Keep a log of the test measurements to find out if gas levels are getting too high (sample copy enclosed). If gas levels are increasing, check your equipment, ventilation system, and operating procedures. Correct any problems.

There are simple measuring devices on the market that can provide the concentration of toxic gases in an arena with +/- 5% accuracy. Some detectors are battery operated to give instant digital readings. Others are capable of recording gas on paper tapes for a permanent record of gas monitoring for up to twenty-four hours per day.

Measurements should be taken in areas where people are likely to be exposed at their breathing zone level. Tests should be taken at:

- Various established areas on the ice surface
- Dressing rooms
- Concession area
- Players' benches
- Bleachers

After testing over a few weeks, the areas of greatest concern can 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 bound and numbered logbook.

APPENDIX A: **Sample Standards and Procedures**

Carbon Monoxide Control and Monitoring

Location:

Anytown Arena

Carbon Monoxide:

Carbon Monoxide is a non-irritating, colourless, odourless, and tasteless gas that may enter the blood and cause headaches and feelings of faintness. Serious exposure may produce irregular heartbeat, unconsciousness and death.

Policy:

The management and staff of the Anytown Arena are committed to maintaining a safe and healthy work environment and will strive to eliminate any foreseeable hazards.

Purpose:

To ensure all employees, participants, and the general public are not exposed to concentrations of carbon monoxide that will adversely affect their health.

Maximum Levels of Exposure:

(1) It shall be the policy of the Anytown Arena that during every hour that the ice is used by the public, the average carbon monoxide level is not to exceed 25 parts per million (ppm).

(2) It shall be the policy of the Anytown Arena that during any 8 hour work period, no worker's exposure shall exceed an average of 25 ppm. Limits of 125 ppm shall not be exceeded at any time during the shift.

Control Measures:

The main sources of combustion gases in the Anytown Arena are from the resurfacing machine and the ice edger. The management of the Arenas will ensure the following procedures are in place to ensure safe levels of exposure are maintained.

1. The exhaust pipe from the ice resurfacer shall be extended to a height of at least one foot above the arena's safety barrier. The exhaust gas shall be discharged vertically upwards.
2. The exhaust pipe shall be insulated to prevent the operator or anyone else being burnt through inadvertent contact.
3. The discharge shall always be directed away from the operator while equipment is mobile (i.e. the operator should not inhale fumes while resurfacing the ice).
4. A catalytic converter shall be installed on the engine's exhaust. For this modification to be effective, the engine shall be warmed up for a t least seven minutes prior to use, in a well-ventilated area or exhausted outside.

5. A maintenance program with final engine tuning through carbon monoxide analysis of exhaust gases shall be performed regularly.

Other control measures to help ensure safe levels of exposure are:

6. Open exterior doors and make-up air louvers during ice resurfacing.
7. Open the resurfacer entrance doors during resurfacing;
8. Turn the ventilation system on and make sure it is operating effectively.

Training:

The staff at the Anytown Arena shall be properly and regularly trained in the following areas:

- Use and maintenance of air quality monitoring equipment
- The recording of air quality data
- Use and maintenance of ice resurfacing equipment
- Ice maintenance practices
- Awareness of hazards and the symptoms associated with excessive exposure to carbon monoxide and nitrogen dioxide (these shall be posted in a visible area within the operations room)
- Emergency procedures with respect to high levels of carbon monoxide and nitrogen dioxide (these shall be posted in a visible area within the operations room)

Monitoring:

The Anytown Arena staff shall:

- Have a schedule for air quality testing
- Record daily air quality testing results on the air testing record sheet
- Take measurements at various established areas on the ice surface, dressing rooms, the concession area, players benches, bleachers and any other area of concern
- Perform periodic calibration of the air monitoring equipment as per manufacturer guidelines
- Review weekly measurements to determine if the implemented control measures are effective and to determine if corrective action is necessary
- Take measurements in the same manner and location

Evaluation:

The Anytown Arena staff shall:

- Perform on a regular basis a detailed review of the facility's air quality program to ensure that the standards set by the facility will continue to be met
- Conduct regular reviews of the procedures for air monitoring to identify areas for improvement
- Hold discussions with facility users on a regular basis as a means to determine if an improvement in air quality is recognized and/or to educate the users with respect to the measures the facility has implemeneted to ensure their safety

Emergency Response:

The Anytown Arena staff shall:

- Respond immediately if air quality tests exceed the maximum exposure levels
- Evacuate the building immediately
- Ventilate the building immediately
- Notify the supervisor without delay
- Repeat air quality tests every 15 minutes and record results
- Allow re-entry into the facility only when air quality tests are below the maximum exposure levels
- Have equipment tested to determine source of carbon monoxide or nitrogen dioxide and perform necessary adjustments and/or repairs

APPENDIX B: **Symptoms of Exposure and Potential Consequences**

Carbon Monoxide: Symptoms and Consequences

Exposure to low levels of carbon monoxide (about 20 ppm) over an extended period (approximately 8 hours) is reported to result in absorption of sufficient amounts to cause slight changes in temporal judgment or visual acuity. These changes are slight and unlikely to be noticed by the affected person. Pre-existing respiratory or circulatory ailments in individuals can be aggravated when levels increase above 30 ppm.

As carbon monoxide exposure increases above 50 ppm, headaches are reported more frequently. Depending on levels in excess of 50 ppm, and the duration of exposure, symptoms will progress from headaches and drowsiness to rapid breathing, nausea and vomiting.

Death can occur at extremely high levels (greater than 800 ppm)

Nitrogen Dioxide: Symptoms and Consequences

At low levels of 0.4 ppm for 3 hours, mild asthmatics were shown to have increased airway reactivity with typical symptoms of cough, wheezing and shortness of breath. At 5 ppm, slight levels of airway resistance may be noted. At moderate levels of 15 to 25 ppm, it can be irritating to the eyes, nose and throat. At higher levels, above 25 ppm more severe symptoms can develop which include pneumonia or bronchiolitis. At these high concentrations there are usually three stages of response.

In the first stage, coughing and irritation, irregular heartbeat, nausea and fatigue may occur but will subside once exposure stops. In the next stage, the person feels fine. The last stage occurs within 6-36 hours when the person may experience symptoms such as rapid breathing, chest pain and flu-like symptoms.

Depending on the severity of exposure, symptoms can progress to include inflammation of the lungs (pneumonitis) or accumulation of fluid in the lungs (pulmonary edema). Individuals with pre-existing respiratory system disorders, such as asthma, may be more sensitive to the effects of nitrogen dioxide.

At high levels, exposure can cause death.

APPENDIX C: **Air Quality Equipment Specifications for Carbon Monoxide**

The following are the recommended minimum specifications recreation facility managers should consider when purchasing carbon monoxide detection equipment.

Range……..…….0-1,999 PPM
Resolution……....1 PPM
Sensor Type……..…..Electrochemical
Sensor Calibration……..Factory Calibration on 100 PPM
Sensor Accuracy……...+/-5% of reading
Operating Temperature…….0 to 40 C

APPENDIX D: **Air Quality Equipment Manufacturers and Suppliers**

<u>Manufacturers</u>
Bacharach, 615 Alpha Drive, Pittsburgh, Pennsylvania 15238-2878
Phone: 412.963.2000 Fax: 412.963.2091
Manufacturers of: Snifit Carbon Monoxide Analyzers, Body Guard 4-Four Gas Personal Monitor, Canary – Single Gas Monitor

Gastec Corporation, 6431 Fukaya, Ayase-shi, Kanagawa 252, Japan
Phone: 0467.79.3910 Fax: 0467.79.3979

Manufacturers of: Gastec 800 Precision Toxic Gas Detection System, Gastech Series Single Gas Monitors, Gastech GT Series Multi-Gas Monitors

Suppliers

Levitt-Safety Limited, 11 Pettipas Drive, Dartmouth, NS, B3B 1K1
Phone: 902.468.5282 Fax: 902.468.5015
Website: www.levitt-safety.com

MicMac Fire and Safety, 121 Ilsley Ave., Dartmouth, NS, B3B 1S4
Phone: 902.468.6060

RL Dennis Associates Limited, 7071 Bayers Rd., Suite 320, Halifax, NS, B3L 2C2
Phone: 902.455.2311 Fax 902.455.1681

APPENDIX E: **Resources**

ASHRAE – Indoor Air Quality Position Paper

British Columbia Recreation Facility Association – Indoor Air Quality in Ice Arenas

Exposure Guidelines for Residential Indoor Air Quality – Health Canada

Guidelines for Resurfacing Operations in Ice Arenas – Nova Scotia

Ontario Recreation Facilities Association – Air Alert Program

Halifax Regional Municipality: Carbon Monoxide Control and Monitoring Policy

Saskatchewan Health – Air Testing Guidelines

Saskatchewan Labour – Air Quality Standards

APPENDIX F: **Contact Information**

Recreation Facility Association of Nova Scotia
5516 Spring Garden Road, 4th Floor
Halifax, NS
B3J 1G6
Phone: 902-425-5454 ext 330
Fax: 902-425-5605
Email: rfans@sportnovascotia.ca
Webpage: www.rfans.com

Nova Scotia Department of Health
PO Box 488
Halifax, NS
B3J 2R8
Phone: 902-424-5818
Fax: 902-424-0550

Nova Scotia Health Promotion
PO Box 864
Halifax, NS
B3J 2V2
Phone: 902-424-7621
Fax: 902-424-0520

Nova Scotia Department of Labour
Occupational Health and Safety Division
PO Box 697
Halifax, NS
B3J 2T8
Phone: 902-424-5400
Fax: 902-424-3239

Nova Scotia Department of the Environment
PO Box 2107
Halifax, NS
B3J 3B7
Phone: 902-424-5300
Fax: 902-424-0503

APPENDIX G: **Notes**

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Mission Statement

To provide leadership in developing, advocating and promoting excellence in recreational facilities, operations and personnel

Member:

Recreation Facility Association of Nova Scotia
5516 Spring Garden Road, 4th Floor
Halifax, NS
B3J 1G6

Phone; 902-425-5450 ext 330
Fax: 902-425-5606
Email: rfans@sportnovascotia.ca
Website: www.rfans.com

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