ORFA

ONTARIO RECREATION FACILITIES ASSOCIATION INC.

Suggested Guidelines For

AIR QUALITY IN ARENAS

September 2001

Ontario Recreation Facilities Association Inc.
1185 Eglinton Avenue East, Suite 402
North York, Ontario
Canada M3C 3C6
T.416.426.7062
F.416.426.7385
1.800.661.6732 (Toll Free in Ontario)
info@orfa.com
www.orfa.com

Human Resources

John Milton
Executive Director
jmilton@orfa.com

Marie Krawczyk
Administrative Assistant
admin@orfa.com

Marie Laurencin
Administrative Assistant
admin@orfa.com

Rebecca Russell
Facilities Librarian
library@orfa.com

Terry Piche
Technical Director
tpiche@onlink.net

Hubie Basilio
Public Relations &
Communications Coordinator
hbasilio@orfa.com

Monica Gurpersaud
Office Assistant
office@orfa.com

Preface

The guidelines presented in this manual have been developed using a number of sources throughout Canada. The purpose is to address the quality of air in Ontario arenas and to provide arena operators with a practical resource to ensure a safe and healthy facility environment. These guidelines are considered to be the minimum standards necessary for safe and responsible arena operation. By reducing emissions at their source, and ensuring proper operation and maintenance, ventilation and monitoring of indoor air levels, the arena operator will be better able to control arena air quality.

Arena operators can improve the air quality in their arenas with some simple preventive maintenance activities. Arenas by their nature are cold, damp buildings. These facilities are not only used for recreation activities but also serve as a place of business. Owners and operators have a duty of care to maintain a safe environment for all patrons and staff. If an acceptable environment is not maintained owners can be found libel for injuries that may occur.

Children are not simply small versions of adults, and this has profound implications for how they are affected by contaminants in their environments. Even before exercising, children breathe at a much higher rate per kilogram of body weight than do adults. Any form of physical exertion will increase this already heightened rate of respiration, which will increase the load of pollutants entering their lungs. Since the biological systems of a child are immature, they absorb many substances (including pollutants) at a higher rate than adults and are less able to metabolize them effectively.

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 CFCs. (For these guidelines consult O.R.F.A.' s "Suggested Guidelines for Entry into Mechanical Rooms")

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

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

The Issue

Since the mid 1980's arena personnel have identified a rising number of incidents relating 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.

The increased awareness of indoor air quality problems by the public and media coverage has once again brought indoor air quality problems to the forefront. Different combustion processes contribute to poor 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 being burned and the condition of burning.

The air we breathe is filled with suspended particles of all sizes and composition. Of particular concern are very fine particles-commonly referred to as PM10 and PM25. Primary sources of these fine particles within indoor recreational skating facilities include ice resurfacing equipment, un-vented space heaters, and environmental tobacco smoke. PM10 and PM25 exhibiting a variety of physical and chemical properties are able to bypass many of the body's natural filtering systems, lodging in the deepest and most sensitive areas of the lungs. Fine particles can aggravate many respiratory illnesses such as asthma, bronchitis, and emphysema. Short-term exposures can lead to coughing and minor throat irritation. Prolonged exposures can lead to increased bronchial aggravations. Nitrogen dioxide particles may combine with water vapour to form nitric acid (a type of acid particle), which may have more significant effects on lung function. The O.R.F.A. recommends that a guideline for fine particles be set at PM10-50 ug/m3 and PM25 of 25 ug/m3.

Indoor combustion sources (including gasoline, propane and natural gas) tend to be intermittent and generally confined to certain areas of the structure. As a result, levels of combustion by-products 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 ice 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 shaved and flooded. In sufficient concentrations of carbon monoxide and nitrogen dioxide are very dangerous, and can be 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 each day in the arena. Participants can spend from one hour to several hours in a facility each day 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 old; very young; 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, propane and natural gas 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 the absorption of sufficient amounts to cause slight changes in temporal judgment or visual activity. 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 exposure levels increase above 30 ppm.

As carbon monoxide exposure increases above 50 ppm, headaches are more frequently reported. 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. At extremely high levels (greater than 800 ppm) there is a risk of death.

Sources of carbon monoxide include:

- ice resurfacer (gasoline, propane or natural gas)
- ice edger (gasoline, propane or natural gas)
- fuel powered floor sweepers

- fuel powered lift trucks
- improperly vented gas fired infrared radiant heaters
- gas fired water heaters
- special events equipment
- vehicles idling in the parking facilities in close proximity to the building.

Nitrogen Dioxide

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

Nitrogen Dioxide (N02) also known as Oxides of Nitrogen (N0X) is a dark brown or reddish brown toxic gas with a pungent, acrid odour. It is present in vehicle and fueled power equipment as unwanted by-products of firing processes at high temperatures.

It can also be found in emissions from combustion appliances gas stoves, furnaces, diesel generators, etc. Nitrogen Dioxide causes shortness of breath, irritation to the eyes, mucus membrane, lungs and other respiratory organs.

You can detect nitrogen dioxide by odour at 5 ppm or below. At this low level (1 to 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 heart beat, 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 (pneumonia) 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.

Other Sources Causing Indoor Air Quality Problems:

- Tobacco smoke
- Construction of air tight buildings
- Reduced intake of outside air
- Construction materials now used – glues, fiberglass, particleboard, concrete, etc.
- Increase in the number of users and building occupants
- Moving outside sports and activities indoors

- Toxic vapour from cleaning chemicals, solvents, disinfectants, pesticides, paints, perfumes and colognes
- Fungus, dust, bacteria, molds (damp buildings)
- Ozone from photo copiers, printers, electric motors
- Inadequate ventilation, exhaust fans/ventilation not properly sized and facility operators not turning exhaust fans on
- Poor construction design – no air louvers to draw in fresh air
- Poorly designed and maintained HVAC systems
- Pollutants present in the outside air entering the building
- Poor temperature and humidity controls
- Refrigerant chemicals, i.e. ammonia, freon
- Hydrocarbons
- Aldehydes
- Indoor Fireworks
- Indoor Shows i.e. monstor trucks, motorcycles, snowmobiles
- Trade shows where motorized vehicle traffic is allowed
- Home shows and use of indoor propane barbeques

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 Ontario, British Columbia, Saskatchewan and Nova Scotia; 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 3 ppm.

    a. Levels above 25 ppm of carbon monoxide can affect vision and balance placing young skaters at risk of having a serious accident.

    b. Levels above 3 ppm of nitrogen dioxide can result in increased breathing difficulty.

2. During any 1-hour work period, no worker's exposure shall exceed an average of 25-ppm carbon dioxide or 3 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 fuel powered equipment.

b. To prevent workers from becoming sick, any exposure to carbon monoxide above 25 ppm, or nitrogen dioxide above 5 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 5 ppm of nitrogen dioxide.

3. Limits of 100 ppm of carbon monoxide shall not be exceeded at any time during the shift. In addition, workers must not be exposed to over 25-ppm carbon monoxide for over 30 minutes and at no time should 100 ppm be exceeded. (Self Contained Breathing Apparatus must be worn when levels are above 100 ppm). Nitrogen dioxide exposure shall not exceed 5 ppm for a 15-minute exposure with at least 60 minutes between successive exposures.

Where it is recognized that a short level of exposure causes health effects, a Short Term Exposure Limit standard is used to supplement the average exposure level. The Short Term Exposure Limit is the maximum that an individual may be exposed to in any 15-minute period throughout an 1-hour period. For nitrogen dioxide this level is set at 5 ppm. Any time this level is reached there must be at least 60 minutes between further exposures at this range.

Please Note: it is recommended that all full-time and part-time facility staff become familiar with the symptoms associated with overexposure to carbon monoxide and nitrogen dioxide. Early detection of an air quality problem may prevent a serious situation from occurring.

Establishing A Program

Consider the safety measures that you as managers and operators of the facility can put in place as you develop your air quality program.

1. Control At Source

2. Control The Environment

An effective air quality program will serve to protect everyone who works, visits or plays in the arena. It is imperative that a program be put in place that monitors, controls and evaluates the air quality on a regular schedule. Providing clean air involves a number of factors that, when implemented properly and consistently, will ensure a program is in place to provide the best possible safest environment for everyone.

A Good Air Quality Program Involves:

- Control Measures (substitution, modification and ventilation);
- Regular Monitoring and Recording;
- Training and Education;
- Building Design;
- Building Signage (products such as ice paint may affect some people when in use);

- Monitoring;
- Evaluation.

Control Measures

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

A safety barrier (rink boards and glass) generally surrounds the ice in order to maintain the ice in uniform condition and to provide a measure of safety for spectators during the hockey game. 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 significantly undiluted due to the lack of air movement. This is caused as the warm air moves away from the cold ice surface.

Reduction In Combustion Product Exposure May Be Achieved Through The Following:

- Elimination of known source of contaminants;
- Modification;
- Ventilation control measures;
- Regular tune-ups and maintenance.

Elimination

Replacing existing equipment, or purchasing first time equipment that 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 changing the facilities and for many community arenas, the cost is significantly more than that of propane, natural gas, or gas operated ice resurfacer. Replacing your ice resurfacer and ice edger to natural gas or propane from gasoline powered is a good start to reducing air problems provided these ice resurfacers are kept tuned regularly and by a qualified licensed mechanic. Electric or battery powered equipment are another alternative but are expensive and have their own source of problems.

Modifications

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 as a safety precaution to prevent burning the operator or anyone else who may inadvertently come in contact with the pipe. The discharge should always be directed away from the operator while the equipment is in operation (i.e., the operator should not be breathing fumes while they are resurfacing the ice).

The addition of a 3-way 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 its effectiveness, and failure may occur without warning. For the catalytic converter to be effective, an engine warm up time of several minutes is required in a well-ventilated area or exhausted directly outdoors.

A regular maintenance program is essential to minimize carbon monoxide levels from gasoline, natural gas and propane-fueled equipment. Also necessary is a final engine tuning through carbon monoxide analysis of exhaust gases. Care must be taken when reducing carbon monoxide levels by carburetion adjustment in order 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 and natural gas fueled machines, and 2% for gasoline fueled machines in equipment without catalytic converters. (A 3 way Catalytic Converter should further reduce this level below 1%) For 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.

Please Note: Only qualified licensed mechanics must complete Carburetion adjustments.

Ventilation Control Measures

Mechanical or natural ventilation can effectively reduce concentrations of air contaminants in an area. There are advantages to both methods of ventilation, and therefore, each facility may incorporate measures best suited for their particular situation. The need for regular preventive maintenance to all HVAC equipment cannot be over stressed.

- All ventilation equipment must be inspected monthly to prevent mechanical failure
- HVAC units and all ventilation equipment must be properly serviced and maintained on a regular basis.

Natural Ventilation

Cracks, windows, doors and/or any opening within the structure that will allow for an exchange of air provide natural ventilation. It is also dependant 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:

- Opening exterior doors and/or make up air louvers provide an added source of fresh air during ice resurfacing;
- Opening resurfacer entrance doors/gates during resurfacing to help break up the inversion layer by increasing air movement.

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 the following needs to occur:

- the system switch must be turned on and operating effectively while fuel-powered equipment is being used.
- the airflow distribution must be adequate to prevent dead spaces.
- the airflow volume must be capable of preventing the accumulation of toxic gases to an unsafe level.

The amount of mechanical ventilation required will depend on:

- frequency of the resurfacer operations;
- air distribution;
- combustion gases emitted from the equipment (usually carbon monoxide is used as a benchmark);
- internal size of the arena;
- whether the system will be used continuously;
- only during resurfacing operation.

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

It is recommended that ventilation equipment be connected to the ice resurfacer (overhead or swing gate) doors so that when the doors are opened the ventilation system automatically turns on.

Training

Staff training is essential. Facility staff must be properly trained at regular intervals in the following areas:

- proper use and knowledge of air quality monitoring equipment;
- proper maintenance of air quality monitoring equipment;
- accurate records of air quality data;
- proper use and maintenance of ice resurfacing and other maintenance equipment;
- proper 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;
- understanding of procedures for air quality within the workplace.

Building Design

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

- installation of adequate ventilation systems;
- installation of air quality monitoring devices;
- importance of the air quality standards identified in this publication are achieved or exceeded.

The designs of adequate ventilation systems for arenas must consider:

- need for adequate ventilation in an effort to minimize levels of toxic gases;
- that large volumes of outside air may interfere with making and maintaining safe ice conditions.

Monitoring

An effective air quality management program can be realized if 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 in place and adhered to by all facility staff;
- That air monitoring be completed at least once per week and is recommended after peak ice maintenance;
- Periodic calibration of the air monitoring equipment be preformed 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;
- Periodic calibration and tune up of the fuel powered equipment.

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 be met;
- Regular reviews of the producers for air monitoring are conducted with the facility staff to identify areas on a regular basis to determine if an improvement in air quality is recognized, and/or to educate the users on the measurements the facility has implemented for their safety;
- 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 with extra copies available upon request from the public and users.

The amount of pollution which equipment produces and the effectiveness of ventilation systems can fluctuate. Therefore, it is recommended that your program include testing the air a minimum of once per week, selecting a time when the equipment is being heavily used. 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 immediately.

There are simple measuring devices on the market that can provide +/- 5 percent accuracy of the concentration of toxic gases in an arena. 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 for carbon monoxide 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
- lobby and concession area
- players benches
- bleachers

Measurements for nitrogen dioxide should be taken at ice and in the centre of the bleachers. With regular testing over a few weeks, the areas of greatest concern can be identified.

Please Note: If diesel powered equipment is being used then you must reverse the testing procedures and take the nitrogen dioxide tests in the recommended carbon monoxide areas and the carbon monoxide tests in the nitrogen dioxide areas.

It is recommended that once established, methods and locations for air quality monitoring remain consistent. In addition, a written record of air quality testing should be maintained in a bound and numbered logbook. (available from O.R.F.A. order #998)

Appendix A:
Sample Standards & Procedures
Carbon Monoxide And Nitrogen Dioxide:
Control And Monitoring
Location

Any town 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.

Nitrogen Dioxide Or Oxides Of Nitrogen:

Nitrogen Dioxide is a dark brown or reddish brown toxic gas with a pungent acid odour that causes shortness of breath, irritation to the eyes, nose, mucus membrane, lungs and other respiratory organs.

Policy:

The management and staff of Anytown Arena are committed to maintaining a safe and healthy environment for those who work and participate in leisure activities. We will strive to eliminate any foreseeable hazards within the facility.

Purpose:

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

Maximum Levels Of Exposure:

- It shall be the policy of 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) or 3 part per million (ppm) of Nitrogen Dioxide.

- It shall be the policy of the Anytown Arena that during any 1-hour work period, no worker's exposure shall exceed an average of 25 ppm of carbon monoxide or 3 ppm of nitrogen dioxide. Limits of 100-ppm carbon monoxide or 5 ppm nitrogen dioxide shall not be exceeded for a 15-minute exposure without at least 60 minutes between successive exposures.

Control Measures:

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

- exhaust pipe from the ice resurfacer shall be extended to a height of at least one foot above the arena's safety barrier (ice boards and glass). The exhaust gas shall be discharged vertically upwards.

- exhaust pipe shall be insulated to prevent the operator or anyone else being burnt through inadvertent contact.

- discharge shall always be directed away from the operator while equipment is in operation (i.e., the operator should not inhale fumes while resurfacing the ice).

- 3-way catalytic converter shall be installed on the engine's exhaust. For this modification to be effective, the engine shall be warmed up for several minutes prior to use, in a well-ventilated area or with exhaust fumes directed outdoors.

- A qualified licensed mechanic shall perform a maintenance program with final engine tuning through carbon monoxide analysis of exhaust gases regularly.

Other Control Measures To Help Ensure Safe Levels Of Exposure:

- Open exterior doors and make-up air louvers during ice resurfacing

- Open the ice resurfacer entrance gates during ice resurfacing

- 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

- proper 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 weekly air quality testing results on the air testing record sheet

- take measurements at various established areas on the ice surface, dressing rooms, the lobby/concession area, players benches bleachers and any other area of concern.

- perform periodic calibration of the air monitoring equipment as per manufacturer's guidelines

- preview weekly measurements to determine if the implemented control measure are effective and to determine if corrective action is necessary

- take measurements in the same manner and location regularly

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 review of the facility's air quality program to ensure that the standards set by the facility will continue to be met.
- 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 implemented 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 & Potential Consequences
Carbon Monoxide: Symptoms & 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 and 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 & Consequences
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 sever 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 heart beat, 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 (pneumonia) 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 Monitoring Equipment

Testing and monitoring the air in your facility is an integral part of a successful air quality program. It is important that facility staff is trained and knowledgeable in the proper use of air monitoring equipment.

Select equipment carefully. Be sure to ask questions about:

- type of battery
- battery life
- sensor and parts warranty
- how often the ice resurfacer requires calibrating and at what cost
- does the ice resurfacer have a digital readout
- does the ice resurfacer provides normal language readouts
- does the ice resurfacer have the capability to have data logging capacity and is it compatible to your computer
- is the ice resurfacer capable of reading low level ranges, i.e. CO -1 ppm and NO3 - 0.1ppm
- is in house staff training provided along with an easy to follow manual
- do they offer a trial period to test the ice resurfacer
- ice resurfacer must be within a + or – 5% accuracy reading
- does the ice resurfacer have an accuracy reading of ! 5% or better.

Monitors with an alarm feature that record air levels 24 hours per day are ideal. Multi-gas detectors will test for both carbon monoxide and nitrogen dioxide but most multi-gas detectors will not read nitrogen dioxide below 1.0 ppm. A 2-way catalytic converter will reduce levels of carbon monoxide and a 3-way catalytic converter will significantly reduce the levels of carbon monoxide and nitrogen dioxide.

Air Quality Equipment Specifications: Carbon Monoxide

The following are the recommended minimum specifications that recreation facility managers/supervisors should consider when purchasing carbon monoxide (and nitrogen dioxide 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

Portable Air Monitoring & Gas Detection Units Suggested Suppliers

CIMCO	(416)-465-7581
Ice Pro	1-888-732-2109
Resurfice Corp.	(519)-669-1694
Aim Safety Inc.	1-800-275-4246
Acklands Grainger	1-800-864-7657
Analygas Systems	(416)-759-2241
Boyer and Associates Inc.	(416)-444-2760
BW Technologies	1-800-663-4164
Draeger	1-877-372-4371
Enmet Ltd.	1-800-367-4706
Fisher Scientific	1-800-234-7437
Industrial Scientific Corp.	1-800-338-3287
Monitech	1-888-458-5555
MSA Canada	(416)-667-9400
Seton	1-800-663-3425
Test Products Int. Ltd.	(905)-693-8558
Quest Technologies	1-800-245-0779
Zefon International	1-800-282-0073

Appendix D:
Contact Information

ONTARIO RECREATION FACILITIES ASSOCIATION

402-1185 Eglinton Avenue East

North York, Ontario, M3C 3C6

Phone: 416-426-7062

Fax: 416-426-7385

e-mail: info@orfa.com

website: www.orfa.com

CANADIAN RECREATION FACILITIES COUNCIL

c/o Fred Horvath

Municipality of Clarington

40 Temperance Street

Bowmanville, Ontario L1C 3A6

Phone: 905-623-3379

Fax: 905-623-4169

E-mail: fhorvath@municipality.clarington.on.ca

STAR – Serving the American Rinks

1775 Bob Johnson Drive

Colorado Springs, Colorado 80906-4090

Phone: 719-538-1149

Fax: 719-538-1160

E-mail: starrinks@usahockey.com

Appendix E:
Workplace Health & Safety Bulletin
Carbon Monoxide At The Work Site

Carbon Monoxide, also called CO, can present a potential hazard to workers. It usually occurs as an unwanted by-product and can result in worker exposure in many different jobs. To ensure protection against CO, workers and employers must be aware of its properties, its health effects and what to do in emergency situations.

Occurrence of Carbon Monoxide

Carbon Monoxide is formed when organic fuels are burned in a limited supply of oxygen. Materials such as coal, coke, wood, oil, gasoline and explosives are examples.

Sources of CO exposure are many and varied. Emissions from internal combustion engines, kiln firing, furnaces, welding and the moulding of plastic materials usually contain some carbon monoxide. It is formed as a by-product during many operations of the forging, ceramic, petroleum, steel and refuse industries.

Space heaters, improperly adjusted oil or gas burners, fires and explosions are other important sources. Cigarette smoking also produces CO.

Carbon monoxide is also used as a raw material in the production of chemical substances such as methanol and acetic acid.

Properties Of Carbon Monoxide

Carbon monoxide is a colourless, odourless and tasteless gas at room temperature. It is flammable. Mixtures of 12 to 75 percent CO in air can catch fire and explode if a spark occurs. A distant spark of flame can ignite a leak and cause an explosion at the source.

Carbon monoxide is stable while under pressure in cylinders at room temperature. However, full or empty cylinders of any gas, including CO, can explode from increased pressure if they are exposed to high temperatures. When heated to high temperatures, carbon monoxide may also react violently with strong oxidizing agents such as oxygen, ozone, peroxides and chlorine.

Effects on the Body

Carbon monoxide enters the body through the lungs. Since it is not irritating and has no odour, a worker may remain unaware of his overexposure for some time.

CO causes adverse health effects because it reduces the amount of oxygen available to the body. When inhaled, carbon monoxide is absorbed into the blood and attaches to the red blood cells. In fact, CO is taken up much more readily than oxygen.

The amount of carbon monoxide, which is taken up by the body depends on the concentration in the air which is inhaled. It also depends on the length of exposure and the rate of breathing. Heavy work, high temperatures and high altitudes may increase the effects of exposure to CO.

Exposure to 200 parts of carbon monoxide per one-million parts of air (ppm) for a few hours may produce symptoms of headache, mental dullness and dizziness. Exposure from 500 ppm to 1000 ppm may cause the rapid onset of nausea, weakness, rapid breathing, heart palpitations and hallucinations. Inhalation of more than 4000 ppm may result in convulsions, heart failure, coma, irreversible brain damage and death. Higher concentrations may be rapidly fatal without producing any warning signs.

Exposure to CO may aggravate heart and artery disease and cause chest pain the those people who have heart problems. People with heart conditions should avoid exposure to carbon monoxide. Prolonged exposure to CO, even at low airborne concentrations, changes the heartbeat and increases blood pressure.

Employer Responsibilities

The Ontario Occupational Health and Safety Act sets out the employer's responsibly to ensure the protection of workers. Regulations under this Act have been established to define standards related to protection from specific hazards.

The Chemical Hazards Regulation covers requirements relating to the control of chemical hazards. It also lists Occupational Exposure Limits (OELs) for various chemicals, including carbon monoxide.

In Ontario, workers must not be exposed to airborne concentrations of CO which average more than 25 ppm over an eight-hour work day. In addition, workers may not be exposed to airborne concentrations of carbon monoxide which average more than 200 ppm over any 15-minutes period during the work day. OELs are subject to periodic change. Please check the Chemical Hazards Regulation for the current limits.

It is important to note that OELs represent basic standards for the protection of health workers. The best approach to protecting workers from exposure to CO is to keep its concentrations as low as possible. In some instances air monitoring may be necessary.

The General Safety Regulation provides standards respecting safety at the work side. These include training, codes of practice, personal protective equipment, etc. Several options are available for protecting workers from exposure to carbon monoxide. These include "engineering out" the hazard, installation of exhaust ventilation, putting safe work procedures in place, regular air quality monitoring, and, when appropriate, using administrative controls. The method used will depend on the conditions at the work site and may require more than one approach. Standards respecting the design and operation of ventilation systems are defined in the Ventilation Regulation.

Where such measures are not adequate to reduce CO concentrations to below the OELs, or in the event of an emergency, appropriate respiratory protective equipment must be used. Workers must also be trained in the use of this equipment. It provides information of the selection, care and use of respiratory protective equipment.

Where carbon monoxide is present at the work site, workers must be aware of the health and safety hazards of carbon monoxide, safe work procedures, first aid information and emergency procedures.

Worker Responsibilities

The Ontario Occupational Health and Safety Act also places responsibilities on the worker for health and safety at the work site. The Act and regulations require the worker to take reasonable care while working. This includes co-operating with the employer for the purpose of protecting himself and others. The worker must:

- take reasonable care to protect his own health and safety and the health and safety of other workers present while he is working.

- become aware of the associated hazards and follow work practices and procedures developed by the employer, and

- wear personal protective equipment supplied by the employer to ensure protection, and follow instructions on correct usage.

In Case Of Emergency

Workers and employers both have responsibilities in an emergency-situation.

The employer must:

- have procedures development in advance of any emergency involving carbon monoxide or nitrogen dioxide;

- ensure that workers are trained in emergency procedures;

- ensure adequate supervision during emergency response, and

The worker must:

- quickly leave the area for fresh air and notify someone else;

- not re-enter a carbon monoxide or nitrogen dioxide filled area of unknown concentration unless equipped with positive-pressure atmosphere-supplying breathing apparatus;

- be prepared to assist fellow workers, while making sure the correct emergency procedures are followed. It is important that the worker be protected properly when assisting or rescuing a fellow worker;

- move an exposed person who has breathed in large amounts of carbon monoxide or nitrogen dioxide to fresh air at once. If breathing has stopped, perform artificial respiration, and;

- seek medical assistance.

Appendix F: Glossary

Air pollutants - Primary pollutants are produced as a result of combustion of fossil and biomass fuels. They include: carbon monoxide, nitrogen oxides, sulphur dioxide and particulates. Secondary air pollutants are formed by chemical and photochemical reactions of primary air pollutants and atmospheric chemicals. Ozone is an example of a photochemical oxidant, the group of oxygenated chemicals formed by photochemical reactions.

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, propane and natural gas than by diesel engines. Carbon monoxide reduces the oxygen carrying capacity of the blood.

Exposure - The result of being brought into contact with a contaminant in the environment

Inhalable particulate - Particulates that have a diameter of less than 10 microns (e.g.; PM2.5, PM10)

Nitrogen Dioxide - Nitrogen Dioxide (NO2) also known as Oxides of Nitrogen (NOx) is a dark brown or reddish brown toxic -as with a pungent, acrid odour. It is present in vehicle and fueled power equipment as unwanted by-products of firing processes at high temperatures. It can also be found in emissions from combustion appliances gas stoves, furnaces, diesel generators, etc. Nitrogen Dioxide causes shortness of breath, irritation to the eyes, mucus membrane, lungs and other respiratory organs.

Nitrogen oxides (NOx : Includes nitric oxide (NO), nitrogen dioxide (NO2), nitrate and its ions.

Ozone - A colourless gas consisting of three oxygen atoms. It is an important component of photochemical smog, and is formed as a result of chemical reactions between nitrogen oxides and volatile organic compounds in the presence of sunlight in the lower atmosphere. Ozone also occurs naturally in the upper atmosphere, where it shields the earth from harmful ultraviolet rays.

PM10 - Particulate matter (PM) with an aerodynamic diameter less than 10 microns (10 millionths of a metre); it includes the finer particles known as PM2.5. The principal sources of these particles are road dust, construction activities, forest fires, agricultural activities and industrial emissions (Ministry of Environment and Energy, 1996). These 'coarse mode' or inhalable particles tend to collect, "in the upper portion of the respiratory system, affecting the bronchial tubes, nose and throat" (McDougall et al., 1993). The constituents of these coarse mode particles include silicone, titanium, aluminum, iron, sodium and chlorine (Bascom et al., 1996).

PM2.5 - Fine or respirable particulates with an aerodynamic diameter less than 2.5 microns. They constitute 50-60% of the total PM2.5 in Ontario, and principle sources include diesel and gasoline engines, fuel combustion, power plants and industrial emissions, (Ministry of Environment and Energy, 1996). These particles can work deep into the lungs, where they remain trapped for a long period of time. They include unburned carbon in fossil fuels which can absorb toxic organic compounds very efficiently. They also include tobacco smoke - "smoking from a single cigarette raises indoor air concentrations of sub-micron particles from 10 to 100 fold" (McDougall et al., 1993) - as well as the irritant acid particle of sulphur oxides and nitrogen oxides.

Respirable particulate - Particulate matter with an aerodynamic diameter of 2.5 microns or less in size, that can easily penetrate deep into the lungs (e.g. Chromium (M) oxidizing for form Chromium (VI).

Acronyms:

CO	Carbon Monoxide
NO	Nitrogen Oxide
N02	Nitrogen Dioxide
NOx	Nitrogen Oxides

PM10 - Particulate matter (PM) with aerodynamic diameters less than 10 microns (10 millionths of a meter)

PM2.5 - Fine or respirable particulates (particulate matter (PM)) with an aerodynamic diameter less than 2.5 microns

Units –

ppb:	parts per billion
ppm:	parts per million

AIR TESTING RECORD

Use this testing record to document gas levels.
If levels are increasing, check to see if your equipment, maintenance program, ventilation system and so forth are working properly.

Arena:	**Location:**
Testing Device:	**Equipment used:**
Serial #:	

Date	**Time**	**Location Tested**	**Conditions/Situation Place**	**Controls in level(ppm)**	**CO**	**NO2**	**Action Taken**	**Initials**
11/16/99	**1600hrs**	**Centre ice**	**5 min. after resurfacing, rain/warm outside**	**resurfacer entrance gate open**	**5**	**n/a**	**none**	

Air Testing Records Shall Be Kept On Site For Review.

Note - Conditions/Situation – Be Sure To Indicate Conditions In Building As Well As Outside Weather Conditions!

management

buildings & grounds

aquatics

ice

"To Be The World–Class Leading Authority Dedicated To The Recreation Facilitation Profession."

ORFA.COM