



Guidelines For Indoor Air Quality In Arenas

VERSION 3.0

ISSUE DATE: JULY 2015

ACKNOWLEDGMENT



Special thanks to the Public Services Health and Safety Association
for the participation in the review and input of this document.

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Introduction

For the past 40 years, the Ontario Recreation Facilities Association Inc. (ORFA), has produced and circulated information on Indoor Air Quality (IAQ) in arenas. ORFA members, who work for extended periods in ice facilities, have the most at stake when it comes to maintaining safe indoor air quality levels. The ORFA is not an authority on air quality issues, but offers the following guidance for maintaining an acceptable indoor air environment for arenas in Ontario. These guidelines do not supersede or circumvent any existing or pending legislation within the Province of Ontario.

Those who work in ice facilities are protected under the *Occupational Health and Safety Act [OHSA]*. An expected elevated level of air contaminants in any work environment is cause to implement a “work refusal”. Arena workers are encouraged to work with their *Joint Health and Safety Committee (JHSC)* on such issues.

The general public is not protected under the OHSA and as such, they must approach their personal safety in a different way. However, the general public is protected under the Occupiers Liability Act; therefore, it is more than reasonable for any person who enters a public ice arena to feel confident in knowing that those who control these facilities are remaining diligent.

Excerpts from the Occupiers Liability Act

Occupiers’ duty

3.(1) An occupier of premises owes a duty to take such care as in all the circumstances of the case is reasonable to see that persons entering on the premises, and the property brought on the premises by those persons are reasonably safe while on the premises.

Idem

(2) The duty of care provided for in subsection (1) applies whether the danger is caused by the condition of the premises or by an activity carried on the premises.

Reasonable Steps to Inform

(3) Where an occupier is free to restrict, modify or exclude the occupiers’ duty of care or the occupiers’

liability for breach thereof, the occupier shall take reasonable steps to bring such restriction, modification or exclusion to the attention of the person to whom the duty is owed. R.S.O. 1990, c. O.2, s. 5.

How Indoor Air Quality Affects Children

Children are not just simply small versions of adults, and this has profound implications for how they are affected by contaminants in their environments.

Under law, children enjoy more protection and require a higher standard of care. Under common law of the Occupier Liabilities Act an owner or occupier of the property must not expose children to potential dangers. The onus is placed on the occupier to know the dangers that are present to the children and take appropriate action.

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.

Arena staff who experience a significant air quality event have most likely failed to implement and maintain an air quality management program. ORFA members are encouraged to review the most recent acceptable levels of indoor air toxins as set out in the OHSA and, at the very least, maintain these levels through regular testing and proactive indoor air management. Keep in mind that the OHSA limits are designed to protect health workers, aged 18 to 65, from adverse health effects. Protection from adverse effects is not the same as maintaining a comfortable environment.

Facility managers/supervisors must also consider how outdoor air and weather conditions may impact their operations. Areas that are regularly affected by “poor air advisories” will have an increased risk of poor ambient air. Ventilating an ice arena by drawing in outdoor air that contains elevated levels of toxins will degrade internal air quality and increase the health risks. Facility staff must be aware that low pressure weather conditions will also impact

inside air quality as natural ventilation will be limited due to the pressurizing of the buildings envelope – restricting the natural air flow of a facility.

Some effects of poor indoor air quality may not be immediate. Persons with asthma may feel the effect of poor indoor air 24-48 hours after leaving the facility. This period of time often does not have the person equating their breathing problem to the facility.

Only through a concentrated commitment to proactive air management plans can we collectively ensure that workers and patrons of Ontario’s recreation facilities remain healthy.

Background

Indoor air quality problems in arenas can be caused by many factors. The identified contributors to IAQ problems include: ventilation system deficiencies, overcrowding, tobacco smoke (from poor policy enforcement or having smoking areas too close to intake air vents), microbiological contamination, outside air pollutants, cleaning chemicals, ultrafine particulate matter (UFP) and refrigerants as well as off-gassing from materials and mechanical equipment.

Elevated levels of carbon monoxide and nitrogen dioxide in ice facilities have been specific cause for alarm in the past.

Ice resurfacing equipment has often been identified as the primary contributor to poor IAQ in arenas. Manufacturers now are committed to meeting or exceeding the standards for complete combustion of fossil fuels indoors. But aging ice cleaning equipment may not now meet the standards set when they were new. Aging affects all equipment in an arena, which may affect IAQ. As a building ages as well, and in the cool, damp environment typical of arenas, corrosion and mould can lead to additional IAQ problems.

In ever-changing conditions, arena managers/supervisors are trained to watch for any indicators of changes in air quality. Some of the key questions they should consider on a regular basis include:

- Is ice cleaning equipment (ice resurfer and or ice edger) being maintained by a qualified professional on a regular basis?

- Is carburation on this fossil fuel equipment being calibrated and inspected at least annually by a qualified professional?
- Is the facility ventilation systems adequately designed to handle air exchange? Are they being used according to specifications? Are they being properly maintained by qualified professionals?
- Is there an air quality testing program for the facility? Is it a sophisticated system that does spot checks during high-use periods to help determine what levels of contaminants exist and determine if corrective measures are needed?
- Are concession foods, cleaning supplies, refrigerant leakage, or public area heating systems contributing to IAQ problems? Are monitoring, use and ventilation standards being properly applied in every part of the building?
- What effect is outdoor air quality having on IAQ? Ventilating an indoor arena during a smog alert may not improve IAQ. Arenas near busy highways or in industrial areas may have IAQ problems that originate outdoors and beside of the facility controls.
- Is there an identified (or hidden) mould problem in the building?

Carbon Monoxide (CO)

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 engines. Carbon monoxide reduces the oxygen carrying capacity of the blood. At very high levels (1200 ppm) Carbon Monoxide is considered to be Immediately Dangerous to Life and Health (IDLH).

Current Ministry of Labour (MOL) occupational exposure limits for Carbon Monoxide are set at 25 ppm for a normal 8-hour working day. The Short Term (15 minute) Exposure Value for Carbon Monoxide is 100 ppm. Maintaining exposures below these levels will prevent adverse health effects for nearly all workers but may not be low enough to protect the young, aged or sensitive members of the public.

Health and Welfare Canada suggests that office levels for Carbon Monoxide should be below 5 ppm.

With the use of gasoline powered equipment such as an ice resurfer, levels below 5 ppm may not be attainable for some facilities. The guiding principle should be *As Low As Reasonably Achievable* (ALARA) and (at the very least) in compliance with the MOL 25 ppm CO occupational exposure limits.

Sources of Carbon Monoxide Include:

- Ice resurfer (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 (NO₂)

When natural gas or propane engines are used, nitrogen dioxide rather than carbon monoxide tends to be the contaminant of most concern. Nitrogen Dioxide (NO₂) also sometimes referred to as Oxides of Nitrogen (NO_x) 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 the combustion process at high temperatures. It can also be found in emissions from combustion appliances and equipment powered by natural gas and or propane, gas stoves, furnaces, diesel generators, etc.

Nitrogen Dioxide causes shortness of breath, irritation to the eyes, mucus membrane, lungs and other respiratory organs. 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 (20 ppm) Nitrogen Dioxide is considered to be Immediately Dangerous to Life and Health (IDLH).

Current Ministry of Labour (MOL) occupational exposure limits for Nitrogen Dioxide are set at 3 ppm for a normal 8-hour working day. The Short Term (15 minute) Exposure Value for Nitrogen Dioxide is 5 ppm. Maintaining exposures below

these levels will prevent adverse health effects for facility staff.

Ultrafine Particulate Matter (UFPs) - Health professionals have long recognized particulate matter as an atmospheric pollutant. While larger diameter particles (10 microns in diameter) have been the main concern in the past, ultrafine particle (UFP) research is an emerging topic and is a relatively new field of investigation. Particles below 1 micron (µm) in diameter are of particular concern to researchers and industrial/occupational hygienists involved in the health-effects of ultrafine particles.

UFPs are considered to be a significant human health concern because of the variable composition and the ability of these particles to penetrate deeply into the respiratory tract. The potential human health impacts from exposure to UFPs are primarily respiratory-related illnesses. This is largely due to the size of UFPs (relative to their mass) and their ability to deposit deeply in the lung.

People suffering from asthma and other respiratory ailments have been identified as especially sensitive to particle pollution. In relatively recent studies, a very consistent picture has emerged between the levels of air pollution (especially fine fraction particles) and increases in significant adverse respiratory affects.

Recent advances in technology have increased the ability to measure ultrafine particles and revealed a new potential human health concern related to particles and air quality. The measurement of ultrafine particles (UFP) is highly complex and generally involves sophisticated and expensive equipment.

To date, there are no known "standards" to collect UltraFine Particulate samples. Ontario's Ministry of Labour continues to investigate this issue.

Guidelines currently suggested by the American Conference of Governmental Industrial Hygienists (ACGIH) indicate that "discomfort" or "odour" complaints are rarely reported when particle counts are below 100,000 UFP/cc of air.

The ORFA recognizes that there is the potential for both short and long term risks associated with UFPs, Carbon Monoxide and Nitrogen Dioxide. If levels are discovered at any time which exceeds the

guideline exposure levels (see below), then an elevated approach to managing indoor air must immediately occur.

Other Sources Causing Indoor Air Quality Problems:

- Construction of air tight buildings
- Reduced intake of outside air
- Cleaning supplies
- Construction materials now used – glues, fibreglass, particleboard, concrete, etc.
- Increase in the number of building occupants
- Moving outside sports and activities indoors
- Perfumes, colognes, tobacco smoke
- Fungus, dust, bacteria, moulds (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 when fuel powered equipment is being used
- Poor construction design – no air louvers to draw in fresh air
- Poorly designed and maintained HVAC
- Pollutants present in the outside air entering the building
- Poor temperature and humidity controls
- Refrigerant chemicals, i.e. ammonia, Freon
- Hydrocarbons from paints or solvents
- Indoor Fireworks
- Indoor shows outside of building designed i.e. monster trucks, motorcycles, snowmobiles
- Trade shows where vehicle traffic is allowed
- Home shows

Levels of Exposure

As previously indicated, the ORFA is not the authority on safe indoor air toxin levels – these are set and maintained under the OHSA. Further, there is a US organization called the *American Conference of Occupational and Environmental Health* that published workplace annual exposure guidelines. <http://www.acgih.org/About/>

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 Canada and are offered as a minimum operational awareness guideline.

1. At no times should the airborne concentration of any contaminant be allowed to exceed the exposure limits for Ontario workers.
 - a. Levels need to be maintained below 25 ppm of carbon monoxide as a time weighted average concentration. Short term exposures must not exceed 100 ppm.
 - b. Levels of nitrogen dioxide must be below 3 ppm as a time weighted average and below 5 ppm as a Short Term Exposure Limit (STEL).

The 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. Any time this level is reached there must be at least 60 minutes between further exposures at this range and no more than four of these excursions in an 8 hour period.

2. Meeting criteria 1 above will not protect all arena patrons: the above limit is for healthy 18 to 65 year old workers. (Criteria 1 outlines the bare legal minimum requirement for facility workers.) Facilities will be attended by both the very young as well as the aged. Typically these groups are less tolerant to chemical exposures and may experience health effects at lower concentrations. Facilities should operate with exposure levels that are As Low As Reasonably Achievable (ALARA), while targeting to achieve Health Canada's outdoor air maximum concentrations. The Canadian Environmental Protection Act cites:
 - a. 5 ppm as the maximum desirable level for Carbon Monoxide in an 8 hour period, and
 - b. 0.032 ppm as the maximum desirable level for Nitrogen Dioxide on an annual basis.

The Best Defense is Awareness and Training

Over the past 40 years, awareness has proven to be an effective tool for managing IAQ issues. Facility staff members who understand the importance of ventilating or purging the building on a regular basis can prevent harmful contaminants from collecting.

When buildings are renovated or new equipment is purchased, staff members who are aware of IAQ can encourage investment in enhanced ventilation systems and choose ice surfacing, cleaning and other equipment that has been designed to reduce IAQ problems.

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.

Under the Occupiers' and Liability Act, it clearly states that it is the responsibility of the building owner and/or owner representative to ensure that the building is safe for use by staff and patrons which would include IAQ.

Establishing a Program

Consider the safety measures that you as managers/supervisors 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 Indoor Air Quality (IAQ) 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, evaluates and controls 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 and safest environment for everyone.

Fossil Fueled Equipment Maintenance

Ontario has approximately 725 ice rinks with more than 1000 ice sheets in operation during the peak skating season. Each sheet would be serviced by ice cleaning equipment on an hourly basis. This will

include a variety of fuel sources – propane, natural gas and gasoline. There would be few if any diesel powered resurfacers in use.

It is a well-known fact that the resurfacer and edger are the most likely source for poor air in an ice arena. Poorly maintained fossil fuel equipment will contribute to elevated Carbon Monoxide and Nitrogen Dioxide levels more than maintained and tested equipment. Electric/battery equipment does not exhaust these pollutants into the arena air.

Industry Best Practice: all fossil fueled equipment is to be serviced and tested at least once per year by a qualified technician.

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 for their particular situation. The need for regular preventive maintenance to all HVAC equipment cannot be overstressed.

- 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.
- Consideration should be given to CO sensors or alarms (with or without interfacing with the air handling system).

Mechanical Ventilation

The ventilation rate required is that which will maintain the carbon monoxide and nitrogen dioxide concentrations within the recommended standards.

ASHRAE 62.1 2007

1.5 L/s fresh air per m² (0.3 cfm/sq.ft of ice) and 3.8 L/s (7.5 cfm) of fresh air per spectator.

Natural Ventilation

Natural ventilation refers to any cracks, windows, doors and/or any opening within the structure that will allow for an exchange of air. It is also dependent on many environmental conditions (i.e., wind velocity, temperature, etc.)

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 additional fresh air during ice resurfacing;
- Opening resurfacer entrance doors/gates during resurfacing helps to break up the inversion layer by increasing air movement.

Industry Best Practice: Facility fresh air intakes should be protected whenever possible from contaminated outdoor air. Vehicles left idling near a fresh air intake will significantly impact indoor air quality. Fresh air intakes should be posted as no idle zones.

Ice Resurfacer/ Refrigeration Room Monitoring

The following requirements are set to help control gas escape at the source. Please confirm that this equipment has been installed and is regularly tested by a qualified technician.

- **Natural Gas** - A methane detector (gas Code B-149) is required within a foot of the ceiling in the room where the ice resurfacer is being refueled. The methane detector and a minimum 200 cfm intrinsically safe extraction fan must be wired in parallel sequence to the remote panel in the room (which the refueling hose runs from).
- **Propane** - Propane gas is heavier than air and as such will sink to low laying areas. Building and gas codes require that all floor vents or snow pit areas be power-vented.
- **Ammonia** - B-52 Mechanical Refrigeration Code requires the installation of gas monitoring systems.

Check the most appropriate building and gas codes for the most up to date information on this requirement. Be sure to consider your supplier as a resource for safe use and installation requirements.

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, including evacuation, with respect to high levels of carbon monoxide and nitrogen dioxide;
- Understanding of procedures for air quality control within the workplace.

Industry Best Practice: Provide all ice arena staff with air quality awareness training as part of an employee orientation and workplace training program.

Role of the Public Health Department

It is important to understand the role of the local Public Health Department in air quality monitoring in ice arenas. Local Public Health inspectors are charged with maintaining public safety with respect to health protection. They may choose to undertake a regular comprehensive air testing program in ice arenas in their regions as part of their mandate. However, this should not be an expected service. It is important to note that such inspections are NOT an air quality testing program. Air quality spot inspections by a Health Inspector should be considered a check and balance to the ongoing efforts of facility staff in this regard.

Facility managers/supervisors should work closely with their Health Inspector in the sharing of information, testing protocols and log book recordings. Feel free to share this document with any health official.

Documenting a Program

Once an internal air quality program has been set up to maintain 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 facility operators need to be aware that the amount of pollution that equipment produces and the effectiveness of ventilation systems can fluctuate.

Industry Best Practice: That a facility air quality monitoring program include testing the air:

- A minimum of once per week
- Selecting a time when the equipment and facility is being heavily used.
- A written record of the test measurements to evaluate if gas levels are getting too high.
- An action plan is to be implemented if toxin levels are too high.

Testing Equipment

The ORFA does not undertake the recommending of specific testing equipment to be purchased. Be aware that no one tester is available to automatically monitor all indoor air toxins. Prior to purchasing a tester the facility manager must first carefully review all Material Safety Data Sheet (MSDS) information relating to chemicals and gases used in the building. This information will be vital in determining what type of tester is required.

You will need to consider a gas detector that can test for a variety of gases. Typical testers in the marketplace check for explosive gases, carbon monoxide and hydrogen sulphide. Each tester will have limitations in identifying even these gases. Asking the representative to explain the limitations of the tester is essential in making the correct purchase.

Beyond the three previously mentioned detector gases, many arenas will need to consider Nitrogen Dioxide and ammonia as possible air toxin to be tested. Aquatic facilities might need to consider other detectors for hazards such as oxygen deficiency, carbon dioxide or chlorine. Monitoring for humidity and temperature levels may also need to be considered as part of an overall monitoring plan.

Advancing technologies continually simplify and expand the features and performance of modern air testing instruments. Older equipment that utilized a stain glass tube detector is no longer acceptable as the most accurate method/equipment. Tubes for

this equipment have a "shelf-life" can be affected by humidity and must be controlled,

There are simple real time 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 plug in devices capable of recording gas concentrations with a data logger for a permanent record of exposure levels.

Gas detectors need to be regularly calibrated. This requirement must be carefully considered as part of the purchasing process. Calibration must be simple so that frontline staff might be able to calibrate on demand.

Industry Best Practice: Owners of arenas should have air quality testing equipment to test air on demand in an ice arena. When purchasing air testing equipment the following criteria should be considered:

Ease of use – the equipment should achieve performance while providing ease of use to all facility safety staff after a relatively short training period

Four (4) gases – when purchasing the equipment it should be able to test for four gases

Calibration – Calibration of testing equipment should be achievable with little difficulty by facility staff or outside service personnel

Testing Protocols

Testing should occur 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
- Spectator bleachers

Please Note: Operators must be aware that for buildings using natural gas or propane powered units should have air monitoring equipment capable of measuring both Carbon Monoxide and Nitrogen Dioxide levels. Propane and natural gas powered units reaching the end of their lifecycle can emit either gas depending on the carburetion settings. If the settings are too rich (propane or natural gas) gives off carbon monoxide; if the

settings are too lean, they can generate excessive levels of nitrogen dioxide. Operators should adjust their testing protocol accordingly to ensure both gases are being effectively monitored. You cannot rely on testing for one gas toxin if using propane or natural gas. Operators should purchase a detector that can read both nitrogen dioxide and carbon monoxide.

Industry Best Practice: 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.

Emergency Evacuation Planning

As required under the Fire Code all facilities must have and practice an emergency evacuation plan. Toxic air evacuation must be added to the facilities planning document.

Industry Best Practice: Arena workers who encounter breaches of any law are expected to complete and submit a facility incident report or follow set policy on dealing with such matters.

User Awareness

The ORFA strongly encourages all facility management to post this document in their facilities for users to access. A copy should also be provided to all primary users of the ice sheet. A copy should be circulated with all community leaders for their general awareness on the issue of poor indoor air in ice arenas.

Safety Check for Indoor Air Quality

The following 10-questions are offered as an internal check and balance for all ice rink operations – facility managers/supervisors. All responses should be made with confidence. You should also be prepared to answer these same 10 questions should any member of the general public step forward with the list.

10-QUESTIONS TO ASK YOUR ARENA MANAGER ON AIR QUALITY IN THEIR FACILITY

QUESTION 3 CAN BE EITHER YES OR NO – ALL OTHERS ANSWERS SHOULD BE YES.

1.	Does this facility conduct air quality tests on a regular basis?
2.	Does it have and maintain a facility air testing log?

3.	Does the local Public Health unit conduct air quality tests in this facility?
4.	Is the ice cleaning equipment maintained by a professional who is properly trained in such matters?
5.	Is the Heating-Ventilating-Air Conditioning and Refrigeration (HVAC) equipment regularly maintained by a professional who is properly trained in such matters?
6.	Does this facility have a training plan for all staff in regards to awareness on the issue of poor air in facilities, how to identify and respond to poor air situations?
7.	Does the facility have a manual ventilation requirement procedure or a well maintained automatic sensor system that is regularly calibrated in place?
8.	Is there a mould management plan in place for the facility?
9.	Does the facility have a copy of the ORFA's Air Quality Guidelines on file?
10.	Does the facility actively monitor emerging issues that can affect indoor air quality or the industry as a whole by reading relevant publications or attend industry related training opportunities?

Independent Facility Air Quality Testing Protocol

Public and worker safety in arenas are our highest priorities. The ORFA encourages all testing by outside agencies for indoor air quality in arenas to follow a protocol suggested below:

- Information on the state of any arena air quality which is to be released to the media must be based on tests conducted by a trained professional;
- A series of indoor tests should be conducted throughout the facility at different times and locations with all results being posted;
- Outside air should be tested and weather patterns observed as part of the process;
- Facility management should be contacted to advise of the planned testing exercise – the “10-Questions to Ask Your Arena Manager on Air Quality in Their Facility” should be part of the testing protocol;

- The person, agency or company conducting the test should feel free to contact the relevant provincial or territorial recreation association to obtain the most up to date information on facility air quality issues and management indoor air management techniques.

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 - A 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 (NO_x) is a dark brown or reddish brown toxic -as with a pungent, acid 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 (NO_x: 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 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; a size that can easily penetrate deep into the lungs (e.g. Chromium (III) oxidizing for form Chromium (VI). Ontario has banned smoking in all public facilities.

Acronyms:

- CO - Carbon Monoxide
- NO - Nitrogen Oxide
- NO₂ - Nitrogen Dioxide
- NO_x - 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
- ppb: parts per billion
- ppm: parts per million

- TLVs - Threshold Limit Values
- TWAEV - time-weighted average exposure value

Understanding Gas Readings/Levels

Reading are in parts per million (ppm) or in % of volume

- 1,000,000ppm = 100% volume
- 100,000ppm = 10% volume
- 10,000ppm = 1% volume
- 1,000ppm = 0.1% volume
- 100ppm = .01% volume
- 10ppm = .001% volume
- 1ppm = .0001% volume
- % Volume = Volume in Air

Oxygen

- (O₂) readings are always in volume %
- Normal oxygen levels are between 19.5-23%
- Readings below 19.5% means that the detection instrument is showing you levels that indicate the start of a lack of breathable air in this space
- Readings above 23.9 indicate a change in the air and that this space is now showing levels in the flammable range area which should cause for alarm as this space is now in the danger zone for a possible fire

Explosive LEL - stands for Lower Explosion Limit and is identical to the LFL (Lower Flammability Limit). It is the lowest concentration of a substance in air that will produce a flash / fire when an ignition source is present. A substance will not support combustion below the LEL since the concentration is to "lean".

UEL - stands for Upper Explosion Limit and is identical to the UFL (Upper Flammability Limit). It is the highest concentration of a substance in air that will produce a flash / fire when an ignition source is present. A substance will not support combustion above the UEL since the concentration is to "rich".

Explosive or Flammable Meters provide digital values between 0 – 100% L.E.L (based on a specific calibration gas). The percent that appears on the meter is the percentage of the LEL for the calibration gas. The calibration gas may not be the same as the gas being detected at the time of use.

If the measurement is over 80% of the LEL, get out immediately and call emergency services (Fire).

Humidity

- Humidity levels should be between 35% RH to 70% RH
- Hockey or skating rink 40 to 55%
- Swimming pool 50% to 65%
- Office setting is 45 to 55% RH.

Carbon Monoxide Levels

- Should not exceed 25 ppm
- Average for a work place or office setting is below 5 ppm

Carbon Dioxide Levels

- Should not exceed a 1000 ppm
- Average for a work place or office setting is below 800 ppm

Air Temperature

- Air temperature will vary depending on the work environment and surroundings.
- Most office settings are around 20 to 22 degree Celsius or 69 to 71 F.

Facility Staff Indoor Air Quality Awareness Test

You have just read the ORFA’s Guidelines for Arena Indoor Air Quality document. This short test will help ensure you have understood the information and reconfirm your commitment to a safer workplace.

1. Any person working in an Ontario workplace is protected under what piece of legislation?

2. What groups of people are at the highest risk from poor indoor air quality and why?

3. When a significant indoor air quality event occurs – what is the most likely reason?

4. Give 3 examples of poor air contributors other than the ice cleaning equipment?

5. Describe Carbon Monoxide?

6. Describe the effects of Carbon Monoxide on the human body?

7. Describe Nitrogen Dioxide?

8. Describe the effects of Nitrogen Dioxide on the human body?

9. What are UFPs?

10. What are considered some of the impacts on the human body from UFPs?

11. What is the most effective approach to managing indoor air quality?

12. To help reduce the risk of poor indoor air – what should occur to the fossil fueled equipment each year?

13. What must be done to the HVAC systems on a regular basis to help reduce the potential for a poor air situation?

14. Natural ventilation is one of the best tools frontline staff have if they suspect a poor indoor air situation is occurring – describe what this means?

15. What are the four primary parts of a facility air quality testing program?

16. Give four recommended locations of where air should be tested in an ice arena?

17. Under the Fire Code each facility must have and practice one of these?

18. Can you answer the 10-questions to ask every facility manager about indoor air quality found in the ORFA's Guidelines for Arena Indoor Air Quality?

Yes ___ No ___

19. If you discover a user group "smoking" in a dressing room – what is your responsibility?

20. Give four examples of how you might help reduce the potential for poor air in your facility.

21. What does the acronym ALARA stand for?

Further Recommended Workplace Specific Training

(Worker to be shown by a competent person)

- The testing equipment and how it works
- How to calibrate the equipment
- Where to conduct air quality tests
- How to log these test results
- How the ventilation system works
- What to do when an emergency occurs and evacuation is required

Workers Signature

Managers Signature

Date: _____

Sources and Acknowledgements:

- Public Services Health & Safety Association Representatives, including Occupational Hygienists with designations of ROH

(Registered Occupational Hygienist and CIH (Certified Industrial Hygienist).

- Health and Safety Ontario - <http://www.healthandsafetyontario.ca/PSHSA/Home.aspx>
- Members of the Canadian Recreation Facilities Council <http://www.crfc.ca>