Ontario Recreation Facilities Association

Building Community Since 1947

Guidelines For Indoor Air Quality In Arenas

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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 ice arenas. ORFA members, who work for extended periods in these 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 ice 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 a cause to implement a "work refusal". Arena workers are encouraged to work with their supervisor and Joint Health and Safety Committee (JHSC) on such issues.

The public is not protected under the OHSA and as such, they must approach their personal safety in a different way. However, the 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 toward the provision of both visible and invisible hazards.

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 are given 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 all the dangers that are present to children and take appropriate actions.

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 toxic 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. Current 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 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 both the natural and mechanical air flow of a facility.

Some effects of poor indoor air quality may not be immediate. Persons with asthma or other breathing conditions may only feel the effect of poor indoor air 24-48 hours after leaving the facility. This period in 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), parking lots or urban road ways with high traffic may create conditions that have the facilities ventilation draw in poor outdoor air, 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 cause for alarm in the past.

Ice resurfacing equipment has often been identified as the primary contributor to poor IAQ in arenas.

Manufacturers are committed to meeting or exceeding the standards for complete combustion of fossil fuels indoors. Often the cause is aging ice cleaning equipment that may not been maintained to meet the original standards. . Aging affects all equipment in an arena, which may affect IAQ. As a building ages the cool, damp environment typical of arenas may cause corrosion and mould which can lend to additional IAQ problems.

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

- Is ice maintenance equipment (ice resurfacer and or ice edger) being maintained by a qualified professional on a regular basis?
- Is carburation on fossil fuel equipment being calibrated and inspected at least annually by a qualified professional?
- Are 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 system that does spot checks during high-use periods to help determine what levels of contaminants exist and determine if corrective measures are needed?
- Is concession equipment , cleaning supplies, refrigerant leakage, or public area heating systems contributing to IAQ problems?
- What effect is outdoor air quality having on IAQ? Ventilating an indoor arena during a smog alert or an area that has high vehicle traffic may not improve ice arena IAQ.
- 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 an 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 exposure level below these ppm will assist in preventing 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 resurfacer, 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 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 near the building.

Nitrogen Dioxide (NO 2)

When natural gas or propane engines are used, nitrogen dioxide rather than carbon monoxide tends to be the contaminant of most concern. Nitrogen Dioxide (N02) also sometimes referred to 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 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 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 concern to researchers and industrial/occupational hygienists involved in the health-effects of ultrafine particles.

UFPs are considered 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, fiberglass, particleboard, concrete, etc.
- Increase in the number of building occupants
- Moving outside sports and activities indoors
- Perfumes, colognes, tobacco smoke
- 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 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 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 Heath 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 ice arena 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. Facilities that use propane indoors, and who are constructing or retrofitting must design the ventilation system to meet the Propane Code.

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/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 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 many factors that, when implemented properly and consistently, will ensure a program is confirming a safe environment for everyone.

Maintaining Fossil Fueled Equipment

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 gasoline and battery powered (electric) units. There would be few if any diesel powered resurfacers in use indoors in Ontario.

The ice resurfacer and edger are often primary sources of poor air in an ice arena. However, manufacturers continue to release state-of-the-art equipment that when first purchased far exceed industry standards for indoor emissions. Most often when ice maintenance equipment is discovered as polluting indoor air, the issue is usually a lack of maintenance of the equipment since purchased. This fact makes facility managements failure to ensure equipment is properly maintained and tested the primary contributor to poor ice arena IAQ.

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

Is Battery Power the Solution?

The introduction of battery powered ice cleaning equipment has revolutionized the ice skating industry. The advancement of battery technology can now ensure that this equipment can perform uninterrupted through a typical ice rink daily schedule. In Ontario, the shift to ice edging battery technology has been embraced. Battery powered edger's are heavy thus assisting the cutting process, offer multiple blades that leave a mirror like finish on the ice surface, are whisper quiet and leave to emissions during the cutting process. Not having to store fossil fuels is of additional benefit. The purchasing of battery powered ice resurfacers has been much slower. This change has most likely been hindered by economics as a typical ice resurfacer can cost as much as 60% more than a fossil fueled unit. Battery technology is not without IAQ risk. The charging of batteries generates a variety of off gases that must be properly ventilated. See: http://www.orfa.com/Resources/Documents/librarydocs/guides_bp/Battery%20Charging%20Unit%20Guidelines%20Jul2014.pdf Battery technology can be an important part of a facilities IAQ management plan but it does not eliminate the need to monitor IAQ for other contributing issues.

Ventilation Control Measures

Mechanical or natural ventilation can both effectively reduce concentrations of air contaminants in an ice arena. 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.
- Consideration should be given to CO sensors or alarms (with or without interfacing with the air handling system).

Mechanical Ventilation

The general ventilation rate required is set to 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. of ice) and 3.8 L/s (7.5 cfm) of fresh air per spectator.

Recent changes to the Propane Code have significantly upgraded ventilation obligations for new or retrofits for any building using propane powered equipment indoors. There is no current obligation for ice rink managers to upgrade older buildings to this new standard however, its should be referenced as part of any IAQ assessment to determine how close or far away the building is to current requirements.

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 ice maintenance :

- 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 ammonia gas monitoring systems.

Check the most appropriate building and gas codes for the most up to date information on these requirement. Suppliers of fossil fueled equipment used indoors are often current with this information.

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;
- Keeping accurate records of air quality data;
- Proper use and maintenance of ice maintenance equipment;
- Proper ice maintenance practices;
- Awareness of hazards and 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.

Increasing Health Department Inspections for Safe Ice Arena IAQ

Ontario's public health (PH) inspectors play an important role in public safety. PH inspectors are regionally focused on specific public health matters that can include testing of indoor ice arena air. How much focus is being placed by local PH departments is often driven by public complaint or concern. Facility management must clearly understand that a PH rink inspection is in fact not only testing IAQ – it is testing the facilities staff to their understanding of the issue and their ability to be proactive in managing toxic arena air before it becomes a public safety issue. PH inspectors have significant power and can issue orders to facility management as they deem best to ensure public safety.

ORFA has been advised that local health inspectors in the Niagara region have been very proactive in conducting air quality testing and general inspections of ice arenas under their care and control. A specific requirement for health inspectors for facilities in their region is to inspect for up to date files for ice resurfacer emissions tests, HVAC and exhaust fan monthly/yearly inspections and any maintenance records for any of these devices. The ORFA has adopted and updated its industry leading IAQ guideline to reflect this recommended industry best practice.

The ORFA extends the use of this resources to any PH department that requests it. PH inspectors often use this document as their primary source of research to their responsibilities.

Documenting the Program

Once the internal air quality program has been set up to monitor IAQ , the program should be documented in writing. Under the "rights" of WHMIS, workers have the right to know about workplace hazards. he written program should be made available to all staff upon request with extra copies being available upon request from the public and users. Facility management would benefit from educating users of the facility on IAQ. Including IAQ information in facility contracts or developing basic awareness information that can be posted internally are both effective tools. The more people watching for increased toxic air problems the safer a facility will be.

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

- A minimum of once per week, or anytime there is an identified IAQ issue
- 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 testing equipment, the facility manager must first carefully review all Safety Data Sheet (SDS) information relating to chemicals and gases used in the building. This information will be vital in determining what type of testing equipment is required.

Typical testers in the marketplace check for explosive gases, carbon monoxide and hydrogen sulphide. Each tester will have limitations in identifying even these gases.

Beyond the three (3) previously mentioned detector gases, many arenas will need to consider Nitrogen Dioxide and ammonia as other possible air toxins to be monitored. Aquatic facilities might further 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 are no longer the preferred method for testing ice arena IAQ. Tubes for this equipment have a "shelf-life" can be affected by humidity and must be controlled,

There are simple real time measuring devices in the marketplace that can provide +/- 5 percent accuracy

of the concentration of toxic gases in many environments under different conditions. . 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 or adjust on demand.

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.

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.

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 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 OTHER 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 PH department conduct regular IAQ tests?
4. Is ice maintenance equipment checked, tested and adjusted by a qualified technician?
5. Is the facilities HVAC-R systems and equipment being checked, tested and maintained by qualified technicians?
6. Does the facility have an IAQ testing program in place that trains staff on the issue and prepares them to respond if toxic air levels are a risk?
7. Do all staff understand the facilities ventilation system design (manual or automatic) and are they trained to use it?
8. Does facility staff monitor for increased mold problems?
9. Does the facility use this resource to train all staff?
10. Is facility management committed to monitoring emerging IAQ issues?

Independent Facility Indoor Air Quality Testing Protocols

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 the 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 because 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 (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 because 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 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 micron. 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
- 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 micron
- 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

UEL - stands for Upper Explosion Limit and is the highest concentration (percentage) of a gas or vapor in air capable of producing a flash of fire in presence of an ignition source (arch, flame, heat). Concentrations higher than UEL are 'too rich' to burn. Also called upper flammable limit (UFL).

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.

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°C to 22°C or 69°F 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 are the most likely reasons?

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

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

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

7. Describe Carbon Monoxide?

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

9. Describe Nitrogen Dioxide?

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

11. 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?

12. What are four (4) primary parts of a facilities IAQ testing program?

13. What are UFPs?

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

15. Provide four (4) recommended locations of where air should be tested in an ice arena?

16. What is considered one of the most effective approaches to managing IAQ?

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

18. Can all facility staff answer the "10-questions to ask every facility manager" regarding indoor air quality found in this resource?

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