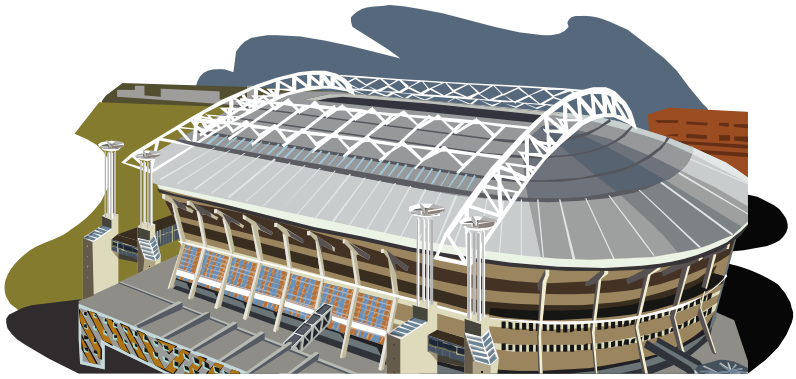

AIR QUALITY GUIDELINES FOR ARENA OPERATIONS IN MANITOBA

February 18, 2009

Table of Contents

Foreword

The guidelines presented in this manual have been developed using Canadian sources. Their purpose is to protect the **health of the public**, by addressing air quality in arena facilities in Manitoba. These guidelines apply specifically to ice-resurfacing equipment with **fuel-burning (combustion)** engines. They do not address electrically powered equipment.

Arena operators are better able to control arena air quality by:

- reducing emissions at their source,
- ensuring proper equipment operation and maintenance,
- monitoring indoor air levels and
- ensuring sufficient ventilation.

Typically, arenas are cold, damp buildings in which an artificial environment is created for users to compete and participate in recreational activities. They are also a place of business and, as such, owners and operators have a duty of care to ensure a safe environment for all users and staff. Owners and operators may otherwise be found liable for injury to patrons and employees.

The scope of these guidelines is limited to carbon monoxide (CO) and nitrogen dioxide (NO_2) emissions. This document does not address other contaminants that may exist in arenas, such as ammonia or chloroform carbons. **These guidelines do not supersede or circumvent any existing or pending legislation in Manitoba.**

The intent of these suggested guidelines is to help promote the ongoing maintenance of safe recreational environments and workplaces throughout the province.

1. The Issue

- Arena staff and patrons have identified and experienced health incidents related to poor arena air quality. Research reveals that air quality problems are linked to several sources that require action.

- Combustion produces many by-products. This guideline focuses on carbon monoxide and nitrogen dioxide. The relative amount of each of these contaminants depends upon the fuel burned and the conditions of burning.

- Indoor combustion sources (gasoline, propane, diesel and natural gas) tend to be intermittent and generally confined to the building. As a result, levels of combustion by-products in indoor air vary with use patterns and from room to room within a building. Conditions around a building (weather, industrial activities, parking etc.) may also be factors related to indoor air quality.

- Ice-resurfacing machines and edgers are a major source of poor air quality in arenas. Arena air quality monitoring has shown that elevated levels of carbon monoxide and nitrogen dioxide occur as ice is being cleaned, flooded and edged.

- Sufficient concentrations of carbon monoxide and nitrogen dioxide are dangerous and may be deadly. Arena operators, participants and spectators are all susceptible to exposure. **The health effects of carbon monoxide and nitrogen dioxide are generally more pronounced for those who are physically active in the arena (i.e. skaters). People who are very young, very old, asthmatic or have an existing heart or lung condition are also more vulnerable to these health effects.**

2. Carbon Monoxide

Carbon monoxide is a colourless, odourless tasteless gas. It is a product of incomplete fuel combustion. There are many possible sources of carbon monoxide in arenas, including the ice-resurfacer (all fuel-burning types), ice edger, gasoline-powered floor sweepers, lift trucks, gas-fired infrared radiant heaters, gas-fired water heaters, special event equipment and vehicles idling in parking facilities close to the building.

Carbon monoxide can be harmful because it reduces the blood's oxygen-carrying capacity. At low levels of exposure, carbon monoxide causes headache, fatigue, shortness of breath and impaired motor functions. These symptoms sometimes feel like the flu. At high levels, or if people are exposed to low levels over a long period, individuals may experience dizziness, chest pain, tiredness, poor vision and difficulty thinking. At very high levels, carbon monoxide can cause convulsions, coma and even death.

3. Nitrogen Dioxide

Nitrogen dioxide is a dark brown or reddish brown toxic gas with a pungent acrid odour. It is present in vehicle and fuel powered equipment as unwanted by-products of firing processes at high temperatures. It can also be found in emissions from combustion appliances such as gas stoves, furnaces, diesel generators etc.

Nitrogen dioxide can cause shortness of breath, irritation to the eyes, throat, lungs and other parts of the respiratory system. Initial symptoms of exposure include coughing and throat irritation, irregular heartbeat, nausea and fatigue. Symptoms usually subside once exposure stops. However, within six to 36 hours the person may experience rapid breathing, chest pain and flu-like symptoms.

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

4. Maximum Levels of Exposure

The health effects of carbon monoxide and nitrogen dioxide are generally more pronounced for people who are physically active (i.e. skaters), very young, very old, asthmatic or have an existing heart or lung condition.

Taking the needs of vulnerable populations into consideration, the following maximum levels of exposure have been established based on scientific evidence and a thorough review of documentation and recommendations from other jurisdictions.

- **During every hour arena ice is in use, the average carbon monoxide level should not exceed 12.5 ppm. The average nitrogen dioxide level should not exceed 0.25 ppm.**
    - Levels above 12.5 ppm of carbon monoxide can affect vision and balance.
    - Levels above 0.25 ppm of nitrogen dioxide can result in increased breathing difficulty.

- **During an eight-hour shift, no worker's exposure should exceed an average of 25 ppm carbon monoxide or 3 ppm nitrogen dioxide.**
    - A worker is potentially exposed to high levels of carbon monoxide and nitrogen dioxide when using ice edgers and other combustion equipment. Any exposure to carbon monoxide above 25 ppm or to nitrogen dioxide above 3 ppm must be offset with lower levels of exposure so that a worker's total daily average exposure is less than 25 ppm of carbon monoxide and less than 3 ppm of nitrogen dioxide.

- For carbon monoxide, exposure may not exceed 75 ppm for more than 30 minutes in an eight-hour work day and at no time may exposure exceed 125 ppm.
- For nitrogen dioxide, an exposure to 5 ppm may not exceed 15 minutes (short-term exposure). Furthermore, exposures at this level may occur no more than four times daily with at least 60 minutes between exposures.

4.1 Levels of Exposure and Required Actions to Protect the Public

Carbon Monoxide	Nitrogen Dioxide	Action
Up to 12.5 ppm	Up to 0.25 ppm	Levels within acceptable parameters; continue with standard operating procedures.
12.5 ppm to 25 ppm	0.25 to 3 ppm	Investigate and take corrective actions. Notify the arena board and document the occurrence.
Greater than 25 ppm	Greater than 3 ppm	Stop all activities within the arena. Investigate and take corrective actions. If carbon monoxide and/or nitrogen dioxide levels continue to rise or remain at unsafe levels, remove all patrons to a well-ventilated area. Notify the arena board and your local Public Health Inspector by calling 944-4888. Document the occurrence.

NOTE

*****All facility staff should become familiar with the symptoms associated with over-exposure to carbon monoxide and nitrogen dioxide. Early detection of an air quality problem may prevent a serious situation. If someone becomes ill in your arena, please notify the Medical Officer of Health in your region by calling the 24-hour Medical Officer of Health line at 788-8666 AFTER arranging appropriate medical care (i.e. dialing 911).*****

5. Other Possible Sources of Indoor Air Quality Problems

- Construction of airtight buildings
- Reduced intake of outside air
- Construction materials (glues, fiberglass, particleboard, concrete etc.)
- Increases in the number of users and building occupants
- Tobacco smoke
- Toxic vapors from cleaning chemicals, solvents, disinfectants, pesticides, paints, perfumes and colognes
- Dampness and mold

- Ozone from photo copiers, printers and electric motors
- Inadequate ventilation (i.e. exhaust fans or ventilation systems improperly sized and/or facility operators not turning on exhaust fans)
- 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)
- Indoor fireworks
- Indoor shows (i.e. monster trucks, motorcycles, snowmobiles. etc.)
- Trade shows where motorized vehicle traffic is allowed
- Home shows and use of indoor propane barbeques

6. Establishing an Air Quality Program

To protect arena users and staff alike, a program must be put in place to monitor, control and evaluate air quality.

A good air quality program involves:

- control measures;
- a remedial action protocol;
- training;
- building design;
- monitoring; and
- evaluation.

6.1 Control Measures

Ice-resurfacing equipment is the major source of combustion gas in ice arenas. A protective barrier (arena boards and glass) usually surrounds the ice to provide a measure of spectator safety. However, the barrier may also allow combustion gases, such as carbon monoxide and nitrogen dioxide, to collect at ice-level, where skaters, workers or spectators may be exposed.

A reduction in combustion product exposure can be achieved in several ways. These include:

- eliminating known contaminant sources;
- modifying equipment and work procedures;
- adopting ventilation control measures.

Eliminating known contaminant sources

- Replacing existing or purchasing new **non-combustion** powered equipment would eliminate most problems arising from using combustion products in arenas. However, although electrical ice resurfacers are now available, they may involve special considerations. For further information on electric powered equipment, please consult with your ice-resurfacer manufacturer.

Modifying equipment and work procedures

- Extend the exhaust pipe from the equipment engine(s) to a height of at least one foot above the arena's safety barrier and discharge exhaust gas upwards. This allows the hot gases to rise and become diluted. The discharge should always be directed ***away*** from the operator while equipment is moving, (i.e. the operator should not be breathing fumes while resurfacing the ice).

- Install three-way catalytic converters on ice-resurfacers. To reduce emissions, an engine warm-up time of at least five minutes is required, either outside or in a well-ventilated, specifically designed room.

- Point source emissions from the ice-resurfacer should be mechanically exhausted to the outside. Ice edgers should only be used at the end of the operating day as it may take several hours of continuous ventilation to reduce by-products produced by the edger.

- Service the ice-resurfacer regularly. Tune up after every **100 hours** of use and analyze the gas content of the engine exhaust to make sure the engine is properly tuned. Ensure catalytic converters are working properly.

Ventilation control measures

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

    1. **Natural**
        - Natural ventilation is provided by cracks, windows, doors and any other opening within the building that allows for an exchange of air. Natural ventilation depends on environmental conditions (i.e. wind velocity, temperature, wind direction etc.).
        - Although it is difficult to control ventilation, arena staff can take steps to remove combustion products during resurfacing operations. For example:
            - opening exterior doors and/or make-up air louvers provides an added source of fresh air during ice resurfacing;
            - opening resurfacer entrance doors during resurfacing increases air movement and helps to break up gases that collect at ice level.

2. **Forced Mechanical**
    - Construction of airtight arenas has created a need for a more controlled method of exhausting and supplying air to supplement natural ventilation. Mechanical ventilation has the advantage of being an operator-controlled system. For mechanical ventilation to be effective:
        - the system switch must be turned on and operating effectively;
        - the air flow distribution must be sufficient to avoid dead space;
        - the air flow volume must be capable of preventing the accumulation of toxic gases to unsafe levels.
    - The extent of mechanical ventilation required depends on the frequency of ice-resurfacing operations, air distribution, combustion gases emitted from the equipment (usually carbon monoxide is used as a benchmark), the internal volume of the arena and whether the system will be used continuously or only during resurfacing operations.
    - Delivery of adequate air volume replacement should occur at the opposite end of the arena from the exhaust to ensure airflow along the entire length of the building (down draft method).

6.2 Remedial Action Protocol

Should carbon monoxide and nitrogen dioxide levels increase in your facility, check and correct the:

- ice-resurfacing equipment;
- ventilation system;
- operating procedures.

6.3 Training

Facility staff should be trained in the following areas:

- Use and maintenance of air quality monitoring equipment
- Recording and analysis of air quality data
- Standard operating procedures including:
    - use and maintenance of ice-resurfacing equipment; and
    - ice maintenance practices.
- Hazard awareness and the symptoms associated with exposure to carbon monoxide and nitrogen dioxide
- Emergency procedures for high levels of carbon monoxide and/or nitrogen dioxide

6.4 Building Design

During facility construction and/or renovation, consideration should be given to:

- ensuring ventilation systems meet appropriate regulatory standards;
- installing air quality monitoring devices in the correct locations; and
- achieving the air quality standards set out in this guideline.

6.5 Monitoring

An effective air quality management program can be achieved if proper monitoring is performed weekly, with accurate monitoring equipment and a well-trained, knowledgeable staff.

Air Quality Monitoring Equipment

- Accepted methods for measuring air quality include:

    1. gas detector tubes certified by the National Institute of Occupational Safety and Health; and/or
    2. any other equipment such as digital direct reading instruments certified by the National Institute of Occupational Safety and Health.

- To ensure effectiveness, periodic calibration of the air monitoring equipment should be performed as per the manufacturer's guidelines.

- For information on where to access air monitoring equipment, please contact Manitoba Culture, Heritage, Tourism and Sport at 1-800-894-3777.

Regular Testing

- A schedule for **weekly** air quality testing by qualified staff should be included in standard operating procedures. Testing should occur at board height at the red line of the ice as soon as ice-resurfacing is completed. The measurement should reflect a time of maximum use of the resurfacing machine.

- A log of all test results should be kept and made available upon request.

- Weekly air quality monitoring data should be reviewed regularly to ensure results fall within acceptable parameters.

6.6 Evaluation

When evaluating an air quality program, conduct:

- an **annual review** of the facility's air quality to ensure that the standards set by the facility continue to be met;
- **monthly reviews** of air monitoring procedures with facility staff to identify areas for improvement.

7. Recordkeeping

- Once an air quality program is established, the program should be documented in writing and then made available upon request.

- Keep a log of test measurements for the following areas:

    - established areas on the ice surface;
    - dressing rooms;
    - concession area;
    - players' benches;
    - bleachers, and
    - any other associated facility areas.

- Annual reports of activities should be made available to the arena operating board.

- Records should be retained to provide historical data.

8. Standard Operating Procedures

Manitoba arena operators should strive to have a written standard operating procedure for their facility, including but not limited to the information specified in Sections 1 to 7 of this guideline. Please see ***Appendix A*** for a sample standard operating procedure.

Appendices

Appendix A: Sample Standard Operating Procedure

ANYTOWN ARENA STANDARD OPERATING PROCEDURES: EXHAUST EMISSIONS CONTROL AND MONITORING

PURPOSE

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

OVERVIEW OF COMBUSTION GASES

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

Nitrogen Dioxide:
Nitrogen dioxide is a dark brown or reddish brown toxic gas with a pungent acrid odour that may cause shortness of breath, irritation to the eyes, throat, lungs and other parts of the respiratory system. Serious exposure can progress to include inflammation of the lungs (pneumonitis) or accumulation of fluid in the lungs (pulmonary edema).

MAXIMUM LEVELS OF EXPOSURE

It is the policy of the Anytown Arena that:

1. During every hour the ice is used by the public, the average carbon monoxide level will not exceed 12.5 parts per million (ppm) and the average nitrogen dioxide will not exceed 0.25 ppm.

2. During an eight-hour work shift, no worker's exposure shall exceed an average of 25 ppm carbon monoxide and/or 3 ppm nitrogen dioxide. **Limits of 125 ppm for carbon monoxide shall not be exceeded at <u>anytime</u> during the shift.**

STAFF TRAINING

All staff at the Anytown Arena will receive regular training in the following areas:

1. Use and maintenance of air quality monitoring equipment;

2. The recording and analysis of air quality data;

3. Ice maintenance practices;

4. Maintenance and servicing of the ice-resurfacer and ice edger;

5. Hazards of and symptoms associated with excessive exposure to carbon monoxide and nitrogen dioxide (these will be posted in a visible area within the operations room);

6. Emergency procedures with respect to high levels of carbon monoxide and nitrogen dioxide (these will be posted in a visible area within the operations room).

Note: New staff must receive an orientation that includes all of the above, prior to operating resurfacing equipment at the Anytown Arena.

EQUIPMENT MODIFICATIONS

In order to limit the accumulation of carbon monoxide and nitrogen dioxide, Anytown Arena management will ensure that the following modifications are made to ice-resurfacing equipment:

1. The exhaust pipe from the ice-resurfacer will be extended to a height of one foot above the arena safety barrier, allowing exhaust to discharge vertically upwards.

2. The exhaust pipe will be insulated to prevent the operators or anyone else from being burned through inadvertent contact.

3. A catalytic converter will be installed on the ice-resurfacer engine exhaust (to be effective this requires the engine to be warmed up for at least five minutes).

EQUIPMENT MAINTENANCE

Anytown Arena staff will service the ice-resurfacer regularly. This will involve following the manufacturer's operational guidelines and, at a minimum, a tune-up after every **100 hours** of use, including an analysis of gas content of the engine exhaust to make sure that the engine is properly tuned.

ICE-RESURFACER AND EDGER OPERATING CHECKLIST

To maintain acceptable levels of carbon monoxide and nitrogen dioxide, Anytown Arena management and staff **must** complete the following checklist **each time ice-resurfacing equipment is in use**.

#	Please ensure the following steps have been taken before resurfacing the ice:	Initial when Complete
1	Turn on the ventilation system and make sure it is operating effectively.	
2	Open exterior doors and make-up louvers (to be kept open during resurfacing).	
3	The ice-resurfacer has been warmed up for at least five minutes and the point source emissions from the ice resurfacer are being mechanically exhausted outside of the building.	
4	Open ice-resurfacer entrance doors (to be kept open during resurfacing).	
5	Ensure that exhaust gases from the ice-resurfacer are discharging vertically upwards during resurfacing.	
6	Ensure that ice-resurfacer/ice edger discharge is directed **away** from the operator (so the operator is not inhaling fumes while resurfacing the ice).	

MONITORING

The Anytown Arena staff will:

1. Have a schedule for weekly air quality testing.

2. Record all air quality testing results on the Air Quality Test Record (below).

3. Take measurements at established areas on the ice surface, dressing rooms, the concession area, players benches, bleachers and any other area of concern.

4. Perform periodic calibration of the air monitoring equipment as per manufacturer guidelines.

5. Review weekly measurements to determine if the implemented control measures are effective and to determine if corrective action is necessary.

6. Take measurements in the same manner and location(s) from one week to the next.

AIR QUALITY TEST RECORD

Air quality testing at Anytown Arena will be done on a weekly basis. Testing will occur just after completion of ice-resurfacing, at a time when the ice is about to be used by skaters.

Test Date:	**Employee Name:**

Location	CO Level	NO2 Level
Ice level (board height at the red line)		
Dressing room		
Players Bench A		
Players Bench B		
Bleachers Section A (marked)		
Bleachers Section B (marked)		
Concession Stand		
Other:		

EVALUATION

The Anytown Arena staff will:

1. regularly perform a detailed review of the facility's air quality program ensuring that the standards set by the facility continue to be met;

2. conduct regular reviews of the procedures for air monitoring to identify areas needing improvement; and

3. regularly hold discussions with facility users to determine if an improvement in air quality is required and/or to educate users with respect to the measures the facility has implemented to ensure safety.

EMERGENCY RESPONSE

When required, the Anytown Arena staff will:

1. ventilate;

2. evacuate; and

3. contact local authorities.

Appendix B: Symptoms of Exposure and Potential Consequences

Carbon Monoxide: Symptoms and Consequences

When a person inhales carbon monoxide (CO), it builds up quickly and combines with the blood to produce "carboxyhemoglobin" (COHb), which reduces the ability of blood to carry oxygen.

The effects of exposure to CO can be very serious:

- At **low levels**, symptoms include headaches, fatigue, shortness of breath and impaired motor functions. These symptoms sometimes feel like the flu.
- At **high levels**, or if people are exposed to **low levels for long periods**, people can experience dizziness, chest pain, tiredness, poor vision and difficulty thinking.
- At **very high levels**, carbon monoxide can cause convulsions, coma and even death.

Nitrogen Dioxide: Symptoms and Consequences

Nitrogen dioxide (NO2) causes shortness of breath, irritation to the eyes, throat, lungs and other parts of the respiratory system.

The effects of exposure to NO2 can be very serious:

- At **low levels** (1-5 ppm), slight shortness of breath may be noted.
- At **moderate levels** (15-25 ppm), it can be irritating to the eyes, nose and throat.
- At **higher levels** (above 25 ppm), more severe symptoms can develop, including inflammation of the lungs (pneumonitis) and/or bronchioles, the tiny airways that lead to the lungs (bronchiolitis).

    - Initial symptoms of exposure to **higher levels** include coughing and irritation, irregular heartbeat, nausea and fatigue. Symptoms usually subside once exposure stops. However, within **six to 36 hours** the person may experience rapid breathing, chest pain and flu-like symptoms.

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

Appendix C: Other Useful Resources

- **ASHRAE-** ***Indoor Air Quality Position Paper***
  www.ashrae.org
- **British Columbia Recreation Facility Association-** ***Indoor Air Quality in Ice Arenas***
  www.rfabc.com
- **Health Canada-** ***Exposure Guidelines for Residential Indoor Air Quality***
  www.hc-sc.gc.ca/ewh-semt/pubs/air/exposure-exposition/index-eng.php
- **Province of Nova Scotia-** ***Guidelines for Resurfacing Operations in Ice Arenas***
  www.rfans.com/default.asp?id=190&pagesize=1&sfield=content.id&search=13&mn=38.276
- **Ontario Recreation Facilities Association-** ***Air Alert Program***
  www.orfa.com/frames.htm
- **Saskatchewan Labour-** ***Air Quality Standards***
  www.labour.gov.sk.ca/arena/

Appendix D: Frequently Asked Questions

Who should I contact if I need advice on developing and implementing standard operating procedures?
Arena operators can contact their local Public Health Inspector for advice and further guidance on creating and implementing their standard operating procedures. To find your local Public Health Inspector Office, please visit:
www.gov.mb.ca/health/publichealth/environmentalhealth/protection/contact.html

When should I test the arena air quality?
Testing should be done on a weekly basis. A good time to test is just after ice-resurfacing is complete and right before skaters are about to use the ice. Ice level testing should occur at board height at the red line.

What should I do if someone becomes ill in the arena?
Any illness among participants, regardless of the gas levels, should trigger immediate ventilation of the arena, a halt to all activities and a full investigation, including notification of the regional Medical Officer of Health (MOH). To find your regional MOH, please visit: www.gov.mb.ca/health/publichealth/cmoh/contactlist.html

When should I call my local Public Health Inspector?
Call your local Public Health Inspector if:

- you have questions about developing and implementing standard operating procedures;
- if air quality test results are routinely higher than recommended levels.

When should I call Health Links- Info Santé?
Call Health Links-Info-Santé if:

- you have questions about the health effects and/or symptoms of exposure to carbon monoxide and/or nitrogen dioxide.

When should I call my regional Medical Officer of Health?
Call your regional Medical Officer of Health or Public Health Office if:

- someone becomes ill or displays signs of exposure to carbon monoxide and/ or nitrogen dioxide.

Appendix E: Contact Information

For **routine** questions or concerns, please call:

Health Links-Info Santé
Phone: **204-788-8200** (in Winnipeg) *or toll-free* **1-888-315-9257**

OR

To find your local **Public Health Inspector Office**, please visit:
www.gov.mb.ca/health/publichealth/environmentalhealth/protection/contact.html

To find your **regional Medical Officer of Health**, please visit:
www.gov.mb.ca/health/publichealth/cmoh/contactlist.html

NOTE: In the event of an emergency, such as an evacuation or an air quality related illness, please contact one of the following, after dialing 911:

1. **Public Health Inspectors**
   (Manitoba Conservation Emergency Response Line):
   Phone: **204-944-4888**

2. **Medical Officer of Health** *(on call)*:
   Phone: **204-788-8666**