



Maintaining Safe Swimming Pool Indoor Air Quality

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Introduction

The potential harmful air quality at indoor swimming pool natatoriums has been an issue and concern raised by ORFA aquatic professionals for many years. The ORFA reminds practitioners that the authors are not an authority on the topic of indoor swimming pool air quality but feel confident that through a basic understanding of the issue and what steps can and should be taken for the reduction of elevated toxic air conditions, that the potential for worker or user exposure risk to this potential workplace and public recreational space hazard can be significantly reduced.

It is reasonable to conclude that the root causes of elevated toxic air levels in indoor swimming pools are a direct result of maintaining swimmer comfort, a lack of attention to basic pool chemistry and water balance, and non-compliance to set requirements under *Ontario Regulation 565* set facility air turnover Code requirements. The primary issue caused by these shortfalls is a build-up of chloramines in the water, which in turn is released into the atmosphere and staff being reluctant to purge the contaminated air through proper ventilation as it creates user discomfort. It is important to note that these conditions may also exist in outdoor swimming pools under certain weather conditions.

Regulation 565

6. (2) every owner and every operator shall, (a) maintain the public pool and its equipment in a safe and sanitary condition.

Causes of Swimming Pool Toxic Air

Unhealthy indoor swimming pool air can be caused by a singular or combination of operational activities or events:

1. Lack of frontline and deck staff training to understanding unhealthy air quality issues in aquatic facilities.

2. Lack of adequate training on proper swimming pool chemical use.
3. Inadequate or poorly maintained ventilation systems.
4. Reluctance of staff to properly use the ventilation system.
5. Inadequate make-up water operational practices.
6. Inadequate or poorly maintained filtration system.
7. Pool skimmer system not functioning properly.
8. Poor water testing activities.
9. Lack of direction and commitment to correcting the issue by pool management.

What is Chloramine?

Chloramine is a chemical compound of chlorine and ammonia. It is considered highly toxic and lethal to marine animals and fish if released into natural water systems. In some communities it is considered as an alternative method for low-level drinking water disinfection. So, if chloramines are used to kill drinking water bacteria, what is the issue in swimming pools? Chlorine in its natural state has a proven benefit as a disinfectant and oxidizer; however, when it combines with organic matter and metabolic wastes left behind by pool users or organic pool cleaning chemicals that enter the pool, the toxic by-products called chloramines can be created. Chloramine is released into the air with pool water evaporation; with the evaporating level increasing when the pool's surface is agitated.



Swimming Pool Irritants

Irritants in the air at swimming pools are usually the combined chlorine by-products of disinfection. These by-products are the result of chlorine oxidizing the sweat, urine, and other swimmer waste. As the concentration of by-products in the water increases, they are released

into the surrounding air as well. Breathing air loaded with such irritants can cause a variety of symptoms depending on their concentration in the air, and the amount of time the air is breathed. The symptoms of exposure to irritants in the air can range from mild, such as coughing, to severe, including wheezing or aggravated asthma. It is also known that routine breathing of irritants may increase sensitivity to other types of irritants such as fungi and bacteria.

Significant Chloramine Toxic By-Products

Research has discovered a variety of by-products of chloramines that are cytotoxic (a substance that has a toxic effect on certain cells) and genotoxic (a toxic agent that damages DNA molecules in genes, causing mutations, tumors). Trichloramine is one of the more dangerous by-products as it is considered a volatile, irritant compound of penetrating odour. It is created as a disinfection by-product in the air of chlorinated indoor swimming pools from reactions of nitrogenous compounds with chlorine.

Pool Indoor Air Quality Exposure Health Effects

As found in poor ice arena indoor air quality situations, children, seniors, and persons with pre-existing health conditions will be the first to react to increased toxic air levels. Pool staff must be prepared to take action when users or staff complain about stinging eyes, nasal irritation, or difficulty breathing. Disregarding these concerns can be considered as the first potential shortfall in addressing the protection of users from the harm of poor air quality. Public pools are controlled by highly trained aquatic staff who are certified to meet Regulation 565 requirements as “deck staff” with an emphasis on protection of users from drowning: not necessarily in an operation or building maintenance role. Studies suggest that pool workers exposed to high Trichloramine levels through extended periods in these environments may experience higher symptoms of upper respiratory health effects. [\[More\]](#)



The ORFA has worked to address this issue in Certified Aquatic Technician training courses. The ORFA identified that in many operations deck staff are considered pool operators with owners believing that their life saving accreditation and skills qualifies them to also operate the pool from their deck chair. Many lifeguards take pool water test readings as required under Regulation 565, but most have not received any formal training in this task. It is further reasonable to assume that the lifeguard’s primary focus will be swimmer safety and pool operations will always be a second priority.



Cleaning and pool maintenance responsibilities are often scheduled at times when there are no users and performed by staff who may be cross-trained having other responsibilities throughout the day. In the pursuit of clean air practices for the elimination of ice arena toxic air situations, the ORFA has found that the primary contributor to user risk was a lack of operator knowledge and training on the subject. It is fast becoming apparent that the same problem exists with operators in identifying and addressing toxic indoor pool air.

Again, like ice arenas, the next significant contributor to toxic air issues in indoor swimming pools would be the reluctance to use proper ventilating procedures. Making full use of available make-up air, exhaust fans, or other air purging systems can decrease air temperature causing user discomfort and an increase in complaints; making it easier for staff to not ventilate than deal with users. Some facilities may also try and control the purging of air and water as an energy/cost reduction program. Human safety should never be sacrificed for energy cost savings.

Worker Safety Obligations

Aquatic facilities with poor indoor air quality are not just offensive to the senses, they can be dangerous to our health. The increased focus on reducing workplace health and safety risks and hazards, must have all aquatic facility owners revisit their legal responsibilities in respect to

indoor toxic air, to ensure that all aquatic staff are safe while at work.



OHSA Duties of employers

25. (1) An employer shall ensure that, (c) the measures and procedures prescribed are carried out in the workplace (2) Without limiting the strict duty imposed by subsection (1), an employer shall, (a) provide information, instruction and supervision to a worker to protect the health or safety of the worker; (d) acquaint a worker or a person in authority over a worker with any hazard in the work and in the handling, storage, use, disposal and transport of any article, device, equipment or a biological, chemical or physical agent; (h) take every precaution reasonable in the circumstances for the protection of a worker.



The Key to a Healthy Pool Environment

Without adequate fresh air, the recycled air flowing over the pool becomes so saturated with water vapour and chlorinated by-products that it can no longer absorb or remove new by-products coming from the pool water.

ASHRAE Standard 62, the industry accepted ventilation code for indoor air quality, defines the minimum volume of outdoor air which must be introduced into the indoor pool enclosure. This volume is generally only a small percentage of the total air volume required by a

dehumidification system to maintain the space humidity. However, it is important to ensure that the air velocities across the pool surface are minimized to avoid excessive evaporation.

The design of the air exchange system should target approximately four to eight air changes per hour.

ASHRAE Ventilation Air Standard

Pool Area: 0.5 cfm / ft²

2.5 liters/s per m²

Spectator Area: 15 cfm / person

8.0 liters/s per person

Air handling equipment that targets high efficiency may only recycle the air without the dilution of outside air. This allows the airborne irritants to accumulate and reach unhealthy levels. In addition, without a constant exhaust that reduces airborne irritants the accumulation of new irritants may cause swimmers to have stinging or red eyes. The exhaust system(s) should target some scavenging of air at low levels (swimmers breathing zone) to reduce the risk of trichloramine accumulating in the air above the pool surface.

Superchlorination is also known as shocking. Superchlorination is commonly used to treat minor pool fouling, in accordance with the pool fouling protocols, algae outbreaks, and in cases where high bacteria counts have been detected. In the latter cases, following Superchlorination, it is advisable to operate at higher Free Available Chlorine (FAC) concentration to avoid future problems. It is a useful tool in water treatment that can provide a quick increase in FAC when necessary to keep the water safe.

It is important to remember that Superchlorination does not necessarily achieve Breakpoint; in fact, if not enough chlorine is added to achieve breakpoint chlorination, the result can be a higher concentration of chloramines in the water. Breakpoint is achieved when enough chlorine is added all in one dose to increase the concentration of free available chlorine to ten (10) times that of the existing combined chlorine concentration.

Break-Point chlorination can be an effective way to rid the pool water of these by-products but will not work if the air is saturated with irritants and ventilation is not

adequate. Therefore, Break-Point should only be carried out when the facility is closed for the evening when the air handling system has several hours to get rid of the contaminated air.

Automation may also be a significant contributor to the issue. Ventilation or chemical controllers may not be designed or set (came out of adjustment) to meet the various demands and environmental changes throughout a typical pool operational day. This may require staff to adjust or manually address toxic air situations. Failing to maintain and test the equipment to ensure it is functioning properly is an important ongoing maintenance responsibility.

Effectively Controlling Toxic Pool Air

It is important to remember that air quality and water quality are dependent on each other.

While a heavily used pool may never be completely chloramine free, you can greatly reduce chloramine production through good pool management practices. The issue of poor indoor pool air quality can be addressed through a combination of preventive measures.

1. Improving air movement over the pool and increasing the air turnover rate will reduce irritant levels in the air.
2. Increased ventilation must be considered when significant bather load occurs.
3. Increased ventilation should also occur when maintenance staff are conducting super chlorination and/or breakpoint chlorination.
4. Ensuring that adequate disinfectant levels and constant monitoring of water quality reduce irritant levels by maintaining adequate free available chlorine concentration and decreasing combined chlorine formation in the water.
 - a. Combined chlorine levels in the water may be reduced by adding secondary disinfection systems, such as ultraviolet light or ozone.
 - b. Combined chlorine concentrations can be reduced by using an organic oxidizer such as Potassium Monopersulphate that oxidizes the organics without creating combined chlorine and leaves the chlorine free to do its work as a disinfectant.

Regulation 565

(7) Every owner and every operator shall ensure that the pool water is treated with chlorine, a chlorine compound or a bromine compound by means of an adjustable dosing device and so maintained that, (a) the total alkalinity is not less than eighty milligrams per litre; (b) the pH value is within the range of 7.2 to 7.8; (c) there is a residual of free available chlorine in every part of the pool of not less than 0.5 milligram per litre.

5. In addition, good swimmer hygiene is needed. Getting swimmers to shower before getting in the pool and promoting regular bathroom use (followed by showering before re-entering the deck area) to reduce the amount of urine in the pool will decrease the formation of irritants.

Regulation 565

15. Every bather shall take a cleansing shower or bath using soap and warm water before entering the deck.

6. Ensure that the correct amount of water is skimmed and filtered and that the required make-up water is added to the pool each day.

Regulation 565

(4) Every owner and every operator shall ensure that, (g) at least 15 per cent of the total pool water volume is capable of being withdrawn from the gutter or skimmer lines daily and discharged to waste drains

(1) Every owner and every operator shall ensure that the clean water and the make-up water are free from contamination that may be injurious to the health of the bathers.

7. (12) Every operator shall add make-up water to the pool during each operating day in an amount not less than twenty litres per bather as determined by a water meter installed for the purpose. R.R.O. 1990, Reg. 565, s. 7 (12).

7. Ensure that all staff are trained to take and make accurate and detailed logbook recordings.

Regulation 565

8. Every operator shall keep and sign daily records that shall set out, (a) the free available chlorine and the total chlorine residuals in the pool water or where a bromine compound is used, the total bromine residual; (b) the pH value of the pool water; (c) the total number of bathers admitted to the pool each day; (d) the reading of the make-up water meter.

A		Common Combustibles	Wood, paper, cloth etc.
B		Flammable liquids and gases	Gasoline, propane and solvents
C		Live electrical equipment	Computers, fax machines <i>(see note!)</i>
D		Combustible metals	Magnesium, lithium, titanium
K		Cooking media	Cooking oils and fats

Fire Safety Equipment

ABC Fire Extinguishers near bulk liquid chlorine storage may not be compatible with Sodium Hypochlorite and could cause a chemical reaction. Extinguishers near bulk chlorine storage (not a concern once the chlorine has been diluted into the pool) with a recommended BC Rated Fire Extinguisher being considered more appropriate. Refer to MSDS.

Industry Best Practices

- Know your pool source water. If the source water is disinfected with chloramines pool management may need to consider a Granulated Activated Carbon filter as the water enters the building and before it enters the swimming pool.
- If a chloramine issue is suspected, it is best to shock the pool and maintain a free residual of *0.5ppm higher* than usual.
- Strictly enforce soapy showers by all swimmers prior to entering the pool to remove excess body oils and sweat, thus greatly reducing the amount of body waste going into the pool. This is estimated that this alone would reduce the chlorine demand by 50%.
- Facility management must work with programming and coaching staff so that they clearly understand the impact of sweat on swimmers and the need to promote pre-activity

showering and the water and human health benefits of mid-event showering.

- Anticipate heavy bather loads and take preventive action - Heavily used pools may be healthier with a chlorine level of 3.0 - 4.0 PPM in order to help prevent chloramines. Try increasing chlorine levels higher for six months. *(This point may be counter-productive in the production of chloramines, maybe even a misstatement in the context of reducing chloramines. While it is advisable to increase free available chlorine concentration in heavy bather load situations, it is done to ensure enough disinfectant is in the water to protect the swimmer's health.... with the increased bather load AND chlorine feed, the increased bathers will add more waste and thus more combined chlorines will be formed, using up the additional chlorine).*
- Consider "Breakpoint Chlorination" more often with free chlorine raising the free chlorine level to at least 10 times higher than the combined chlorine level (10 times is considered break point). No less than once per week for most pools, but it may be required even more often for extremely heavily used pools - Consider using a non-chlorine shocking agent to help reduce chloramines. Some operators find that switching from a traditional chlorine to a non-chlorine based shocking agent assists in their chloramine control plan BUT do not overuse shocking for maintenance purposes.
- Facilities that continually struggle with chloramines might consider adding a Granulated Activated Carbon (GAC) filters to existing filtration/circulation systems to help remove ammonia that produces chloramines in the pool water - Consider adding volcanic ash to sand filters as it will hold ammonia in the filter tank rather than in the pool and a dechlorinating ultraviolet system should be considered.
- Using a good clean source of fresh water, give pool filters an extended backwash and drain off a significant amount of existing pool water (up to 1/3 of your pool volume) and replace it with fresh water.
- Review the current filtration system to determine if a higher micron rating (Diatomaceous Earth (DE) at 4) would be more effective.

- Evaluate the types and brands of chemicals being used to treat the pool water for both chlorine and pH control.
- Implement a comprehensive air handler maintenance plan that ensures that filters are maintained as per the manufacture’s recommendations.
- Increase pool maintenance - vacuuming and brushing the pool daily will remove much of the dirt chlorine before it has time to react.
- Ensure that cleaning chemicals being used on the deck do not contain ammonia or nitrogen.
- Consider a pool cover. They are labour intensive but will provide significant energy savings as well as reducing the evaporation of both water and chemicals, thus helping to reduce unwanted air irritants. At minimum a cover on a spa should be used.

7.	Ensure that pool deck chemicals are not contributing to operational issues and that staff are properly trained to use them.	
8.	Ensure that outdoor ventilation and exhaust code levels are maintained during use periods.	



Conclusion

Controlling indoor toxic air in swimming pools is attainable with a basic understanding with respect to what causes the issue and being prepared to address historical reasons as to why it occurs.

	Management must ensure that:	<input checked="" type="checkbox"/>
1.	Frontline staff are properly trained in pool operations, chemical use, maintenance and the associated risks and hazards.	
2.	Deck staff are trained to identify and report toxic air situations and the importance of understanding water testing results.	
3.	A comprehensive maintenance plan for both air and water filtration systems is developed and maintained.	
4.	Both staff and users understand the need and benefit of good air exchange.	
5.	Detailed Standard Operating Practices (SOP) are developed and used in all aspects of pool operations.	
6.	Ensure that make-up water calculations are collected and that the corresponding release of pool water occurs, and fresh water is applied.	

The ORFA has significantly invested in the creation of aquatic training courses that are Ontario based. Our training and accreditation programs are designed to assist aquatic managers in ensuring that their staff are receiving the most up to date and current information in safe swimming pool operations specific for our province. We encourage facility owners and managers to investigate this when selecting the most current accreditation programs. Some are American based, and Ontario provincial regulatory obligations may not be covered in detail, if not at all. It is facility management’s responsibility to ensure that all staff are competent as defined in the Ontario Occupational Health and Safety Act:

“Competent person” means a person who,
(a) is qualified because of knowledge, training and experience to organize the work and its performance,
(b) is familiar with the OHSA and the regulations that apply to the work, and
(c) has knowledge of any potential or actual danger to health or safety in the workplace.

If workers are not arriving with this legally required knowledge base, it is the employer’s responsibility to ensure that it is obtained. The ORFA further reminds its members that obtaining “certification” in 2-3 days of in-class training does not achieve competence. Competence can only be obtained through education, detailed policy and procedures and a comprehensive workplace specific training plan.

The ORFA encourages all aquatic practitioners, including deck staff, to consider the benefits of training that has been *built by Ontario practitioners, for Ontario practitioners*. The [Certified Aquatic Technician professional designation](#) is considered the provincial standard for competency to be met.

Resources:

- [Regulation 565](#)
- [Occupational Health & Safety Act](#)