Natatorium Air Quality Problems

by Alison Osinski, Ph.D.

Control measures can reduce the level of exposure to contaminants in the environment. Some contaminants can be contained by installing barriers. For instance health clubs should not use the same space to house both the pool and aerobic areas, nor should those areas share the same air. Administrative controls can be instituted. Smoking policies can be enforced. Time restriction on the number of hours spent working in the natatorium can be implemented. The HVAC system can be upgraded to better control temperature and humidity, redistribute the air flow, and increase the ventilation and percentage of fresh air brought into the natatorium. Contaminants can be removed from the building and replaced with less hazardous substances.

Enforce compliance with OSHA Permissible Exposure Limits (PELs), including 8-hour time weighted average (TWA) concentrations, ceiling limits (CL) — the maximum concentration for exposure at any time during an 8-hour work shift, and action levels (AL). Remember that exposure can exceed the AL for a specific amount of time, but the employer must prevent the contaminant concentration from reaching the PEL. Similarly ACGIH limits should be followed for regulated chemicals. The American Conference of Governmental Industrial Hygienists, a trade organization for occupational and environmental health professionals, establishes and annually updates recommended exposure standards, including concentration of airborne substances to which most workers can be exposed daily without harming their health called Threshold Limit Values (TLV). Threshold Limit Values include TLV - TWA (time weighted average for an 8 hour workday in a 40 hour work week), TLV - STEL (maximum short term exposure limit), and TLV - C (concentration ceiling that should not be exceeded).

Finding a solution to an air quality problem first requires that the problem be recognized and admitted. Gather information by making observations, reviewing complaints that have been filed, interviewing staff members, and surveying participants. Review the Material Safety Data Sheets (MSDS) for all substances used in the natatorium. Next, evaluate and measure the extent of the problem.

Natatorium air must be sampled so that it can be analyzed quantitatively and qualitatively. Air samples should be gathered from the area six inches above the pool water surface, and from the personal breathing zone of employees who work in the natatorium. Air contaminants can be sampled using volumetric pumps, direct reading electronic instruments like dosimeters, wall mounted air monitoring devices, or by having pool employees wear personal dosimeters, detection tubes or chemical monitoring badges. Collection of biological specimens (blood, tissue, urine, exhaled air) may also be necessary.

A variety of analytical tools can be used for evaluating the natatorium environment. Air motion is evaluated using foggers and smoke tubes. Air velocity is measured in feet per minute with a mechanical air velocity meter or anemometer. Air flow is measured in cubic feet per minute using an air flow meter, or with a balancing hood and adapter. Hygrometers, thermometers, light meters, and sound level meters are used to gauge relative humidity, temperature, illumination and noise levels, respectively.

If results of tests show overexposure in excess of exposure limits, the employer must take immediate steps to reduce the level of contaminants. In the meantime, adjustments should be made in work hours, or the way in which work is performed.

An often ignored component of natatorium air quality is relative humidity. Relative humidity is a reflection of the percentage of moisture in the air compared to the amount of moisture the air could hold if it was saturated at the same temperature. ASHRAE (American Society for Heating, Refrigeration and Air Conditioning Engineers) Standard 55-1992 recommends that relative humidity of all occupied spaces be maintained between 30 and 60%. Ideally, natatorium relative humidity levels should remain low, between 50% and 60% during the summer months, and between 30% and 50% in the winter or when outside temperatures dip below 45° F. Maintaining excessively low humidity in a natatorium can cause dry skin, chapped lips, nose bleeding, and sore throats. High humidity can cause corrosion problems, and major damage to interior natatorium surfaces that have a tendency to escalate rapidly. Humid conditions are also favorable for growth of bacteria, yeasts and molds.

Probably the most serious result of long term maintenance of high relative humidity levels and inadequate ventilation of chemically laden air in the pool environment, is pool ceiling collapses. Moisture infiltrates concrete and other building materials and weakens them. Pitting, stress corrosion, and cracking occurs. The cumulative effect of years of exposure of coated stainless or galvanized steel hangars, cement, ceiling panels, conduit, hanging light fixtures, steel beams, and reinforcing bar to chlorine vapors is transcrystalline tension-crack corrosion. When ceiling supports can't withstand the tensile load, the whole ceiling gives way and falls into the pool. Look for signs of possible ceiling damage such as water dripping or rain falling onto the pool deck from the ceiling, water logged or sagging suspended ceiling panels, evident corrosion and staining of beams and metal objects in the pool area, rotted wood, moisture condensation on windows, skylights or walls; and chlorine dusting stains left behind by evaporated water on the ceiling and natatorium walls. If any signs of deterioration are present, hire a registered professional engineer to inspect for structural integrity of the ceiling over the pool. Annual inspection of commercial pool ceilings is required by the state of Massachusetts.

Ambient air temperature in a natatorium should be comfortable, and appropriate for activities being conducted, level of activity, and desires of the primary or priority user group. Air temperature should be maintained two to seven degrees higher than pool water temperature. ASHRAE Standard 55-1992 "Thermal Environmental Conditions for Human Occupancy" requires that thermal environmental conditions (temperature and relative humidity) be acceptable to at least 80% of the occupants.

Air temperature should not fluctuate, but should be constant. When not in use, an indoor pool should be covered. Insulating pool covers prevent dirt and debris from entering pool, reduce maintenance time, heating costs, and chemical dissipation; and conserve make-up water. More importantly though, covering pools reduces the need to ventilate indoor pools and pre heat or pre cool outside air, helps prevent rusting and deterioration of structural components, and improves indoor air quality.

The majority of indoor pools are not properly ventilated. At least

cont.'d on page 20

Natatorium Air Quality Problems

cont.'d from page 18

six, and preferably eight complete air exchanges per hour should occur in a natatorium. This is measured by dividing the quantity of outdoor air brought in by the building volume.

Fresh air should be introduced at a rate of 0.5 cfm (cubic feet per minute) per square foot of pool and deck area, plus another 15 to 25 cfm for each anticipated bather or spectator, depending on the activity level of pool users. Compliance with ASHRAE Standard 62-1989 "Ventilation for Acceptable Indoor Air Quality" should be the minimum requirement. The ASHRAE ventilation rate procedure requires that ventilation rates be based on space function, at a minimum rate of 15 cfm per person, and that carbon dioxide levels be maintained below 0.1 % or 1,000 ppm.

Regardless of the adequacy of the ventilation rate, the air distribution system in a natatorium must be properly designed. Air should always be introduced into the pool area from low to high. Return air grilles should be installed near deck level. A very common natatorium design error involves installing all the ductwork at ceiling level. Introducing warm supply air through diffusers installed in the ceiling 15 to 30 feet above the pool will almost guarantee bather discomfort. Since warm air rises, there is almost no chance that warm air supplied at ceiling level will ever reach the deck or pool. Unless supplied at a very high velocity, ceiling supplied warm air will just cling to the ceiling and be vented out of the natatorium. Reduced bather comfort due to drafts and temperature gradients; and serious water quality problems resulting from inability to completely oxidize organic contaminants or reach chlorine breakpoint due to lack of oxygen over the pool can be traced to this problem

Sidebar

Air Quality Standards have been developed and are available from the following organizations:

- Occupational Safety and Health Administration "Permissible Exposure Limits"
- U. S. Environmental Protection Agency "National Ambient Air Quality Standards"
- American Conference of Governmental Industrial Hygienists "Threshold Limit Values"
- American Society of Heating, Refrigeration and Air Conditioning Engineers
  "Standard 62-1989 - Ventilation for Acceptable Indoor Air Quality"
  "Standard 55-1992 - Thermal Environmental Conditions for Human Occupancy"
- American Industrial Hygiene Association "Workplace Environmental Exposure Levels
- National Institute for Occupational Safety and Health "Recommended Exposure Levels
- World Health Organization "Air Quality Guidelines for Europe"
- Canada Environmental Health Directorate "Exposure Guidelines for Indoor Air Quality"

References

Hayes, S., R. Gobbell, and N. Ganick, (1995). "Indoor air quality: Solutions and strategies." New York: McGraw - Hill.

Hennessey III, J. (1992, July). "How to solve indoor air quality problems, Building Operating Management." p. 25.

"Introduction to indoor air quality: A self-paced learning module." (1991). [U.S. EPA document 400/3/91/002]

Levesque, B., et al. (1994, December). "Evaluation of dermal and respiratory chloroform exposure in humans." Environmental Health Perspectives. 102 (12), pp. 1082 - 1087.

Raloff, J. (1995, January 7). "Swimmers may get hefty chloroform dose." Science News. 147 (1), p. 5.

Williams, K. (1995, Winter). "Swimmers may get hefty chloroform dose." Pump Room Press. p. 3.

This article appears as Part Three of a Three Part Series. Part One appeared in the August/September 1995 issue. Part Two appeared in the October/November issue 1995.

Alison Osinski is the principal-owner of Aquatic Consulting Services, located in San Diego, California, specializing in aquatic risk management, aquatic program development, boating safety, water quality analysis, staff training, and aquatic facility design, maintenance and operation.

Dr. Osinski is an author with over 70 publications to her credit, workshop coordinator and frequent speaker at national aquatic conferences. She has served as an expert witness on over 75 aquatic cases involving personal injury or pool construction defects. She is actively involved, and currently serves as an officer or advisory board member, with several national and regional aquatic organizations.

Dr. Osinski also runs the "Swimming Pool Hotline" (900-446-6075, ext 82) and provides phone information directly to aquatic professionals and pool owners and operators.

SPECIAL UPDATE:

As of October 1995, the Pacific Justice Center and CA Attorney General's Office have renewed litigation mentioned in Part I. Although fewer defendants have been named, chlorine as well as bromine by-products are now listed.