CALIFORNIA CONFERENCE OF DIRECTORS OF ENVIRONMENTAL HEALTH
RECREATIONAL HEALTH TECHNICAL ADVISORY COMMITTEE

OZONE GENERATING SYSTEM GUIDELINES
For
COMMERCIAL POOLS AND SPAS
(adopted September 2007 at CCDEH Annual Conference)

A. General Requirements

The following shall apply when ozone generating equipment is used:

A free halogen residual shall be maintained in the pool water at all times as required in Section 65529, Title 22 of the California Code of Regulations. Ozone generating equipment shall only be used to augment the required free halogen residual.

The owner/operator submitting plans for an ozone generating system shall obtain approval from the local building department, fire authority, or other regulatory agencies before placing the ozone generating equipment into operation.

Ozone generating equipment and its components shall meet the applicable requirements contained in NSF International standards – NSF/ANSI 50 and be listed by NSF International or equivalent organization recognized by the department.

Ozone generating equipment shall be installed, used, and maintained in accordance with the manufacturer's specifications and recommendations.

All pipes, gaskets, valves, fittings, and sealants which come into contact with ozone shall be made of materials which are resistant to ozone and shall be inspected for leaks on a routine basis.

See Appendix A for Material Selection

Parts of ozone generating equipment requiring cleaning and maintenance shall be readily accessible.

The ozone generating equipment shall be provided with an effective means to alert the operator when a component of the equipment is not operating.

Ozone shall be delivered to the pool recirculation system using a vacuum system such as a venturi where a loss of vacuum will interrupt the flow of ozone.

NOTE
For generators that produce ozone under vacuum and utilize a negative pressure (Venturi) ozone delivery system, any leak or break in the system after the generator, allows air to be drawn into the system eliminating the potential for ozone release. This condition stops the feedgas flow through the generator, thereby stopping the production of ozone.

For generators that produce ozone under pressure and utilize a negative pressure (Venturi) ozone delivery system, any leak or break in the system will immediately cause the release of ozone unless specific precautions are taken. Therefore pressure systems shall be excluded from indoor use.

Ozone generating equipment shall be equipped with an air flow meter and a means to control the airflow.

A check valve shall be installed between the ozone generator and the injection point.

The ozone injection point shall be located in the pool return line after the filtration and heating equipment, prior to the disinfectant injection point and a minimum of 10 (ten) feet from the nearest pool return outlet.

Ozone injection methods shall provide efficient mixing of ozone with the recirculation water. Typical injection methods include injectors, and mixing towers or contact tanks with degas and destruct devices. The injection and mixing system shall not prevent the attainment of the turnover rate required in Section 3124B, Title 24 of the California Code of Regulations.

The ozone equipment room shall not be used for storage of chemicals, solvents, or any combustible materials other than those required for the operation of the pool and ozone generating equipment.

There shall be a "standard operating procedure manual" containing information on the operation and maintenance of the ozone generating equipment, including the responsibilities of workers in an emergency. All employees shall be properly trained in the operation and maintenance of the equipment. Refresher training shall be conducted a minimum of once every 6 months.

B. Ozone Generating Equipment Located Indoors

When ozone generating equipment is located indoors the following apply:

The ozone concentration in the equipment room atmosphere shall not exceed 0.1 ppm. The general ventilation system for the room containing the ozone generating equipment shall provide a minimum of 6 (six) air changes per hour. The equipment room shall be equipped with a continuous gas detection system that will shut off the ozone generating equipment and sound a local alarm when concentrations above the permissible exposure limit occur. (Refer to the Uniform Fire Code, Annex G. G.4.3, 2006 Edition; International Fire Code, Section 3705.3.2, 2006 Edition)

The audio and visual ozone detection/alarm system sensor shall be located in the room containing the ozone generation equipment. The sensor shall be located at a height of 18-24" off the floor. The system shall be capable of measuring ozone in the range of 0 to 2 ppm. The system shall activate when ozone concentrations reach 0.1 ppm in the room. Activation of the alarm shall shut off the ozone generating equipment and provide an audible and visual alarm. The alarm system shall consist of the following:

An audible alarm capable of producing sound at least 90 (ninety) decibels
A visual alarm consisting of a flashing light, mounted directly outside the entrance of the ozone equipment room. The light shall have an intensity that is clearly visible during daylight hours.

Properly labeled on/off switch shall be located directly outside of the ozone room that controls the ozone generator.

There shall be posted in a conspicuous place on the exterior of the entry door to the room containing the ozone generating equipment or on the adjacent wall area a sign stating “OZONE GAS GENERATOR – HIGHLY TOXIC – OXIDIZER” (Refer to Uniform Fire Code Annex G G.4.3, 2006 edition; International Fire Code, Section 3705.3.2, 2006 Edition) with clearly legible letters not less than 4 (four) inches high.

Exit doors from the ozone generating equipment room shall open outward.

C. Ozone System Requirements

The residual ozone concentration in the pool water shall not exceed 0.1 milligrams per liter (mg/L or PPM). This may be accomplished by **one** of the following methods:

The ozone generating equipment shall be designed, sized and controlled utilizing an ORP Monitor/Controller so that the dissolved ozone residual concentration remains below 0.1 mg/L (PPM) in the pool.

For efficient, effective and safe operation the ozone generator and its components shall be combined with all of the following general components (see Figure 1):

- Ozone generator
- Injector/Injector Manifold
- Reaction Tank (Contact Tank) / Mixing/Degas Tower
- Degas Valve (to vent undissolved gaseous ozone)
- Ozone Destruct (to destroy undissolved gaseous ozone)

OR

The ozone generating equipment shall have an aqueous ozone removal system that will reduce the aqueous ozone concentration below 0.1 mg/L prior to its introduction into the pool. Examples include granular activated carbon or UV decomposition.

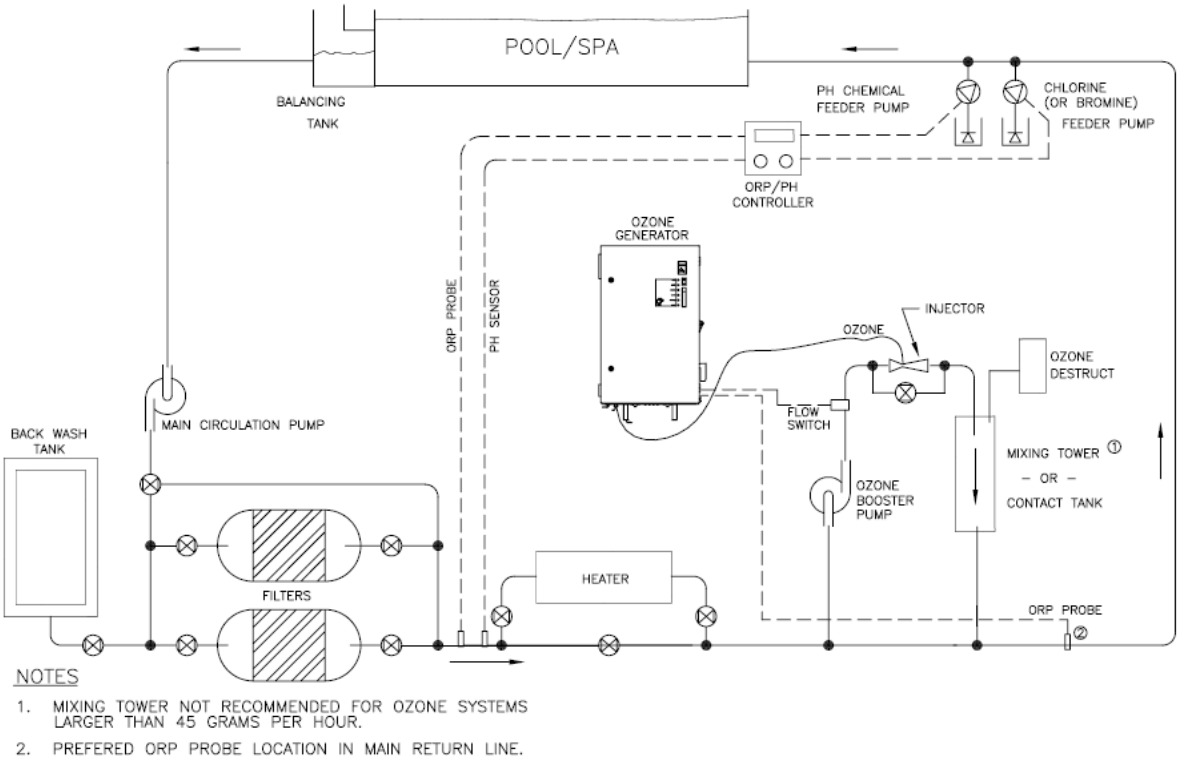

Figure 1: Side stream ozonation system schematic diagram.

The ozone generator shall include the following characteristics for safe, consistent, low maintenance operation and long service life.

Generator module shall be constructed of all non-combustible and ozone resistant materials such as stainless steel, ceramic, glass, etc.

Generator shall be designed to maintain ozone under vacuum from generation to the point of injection in the water stream. Automatic feed-gas flow control shall be incorporated to maintain a vacuum set-point and correct for variations in suction. Minimum protection against vacuum loss shall be included.

Water backflow protection shall be included in the ozone gas delivery line. This shall be an interlock to the control system causing an immediate shutdown of all high voltage circuits and isolating the generator module if water is detected, or an internal check valve.

Automatic shut down shall occur under any of the following conditions:

- door open or cover panel removed from the generator cabinet
- low feed-gas supply
- loss of vacuum
- high temperature of the ozone generator module and/or high voltage transformer
- loss of recirculation or side-stream water flow (including during backwash cycle)
- high dew point in the feed air (not necessary if oxygen is used)
-

Ozone generators shall be marked with legible and permanent identification showing:

- manufacturer and/or supplier
- model number
- serial number
- NSF listing mark (or equivalent)
- date of manufacture
- electrical requirements
- type of feed-gas
- rated feed-gas flow rate (SCFH or LPM)
- rated ozone production (grams/hour or lb/day)
- rated ozone concentration (% weight or ppm)
- method of cooling and coolant flow rates
- wiring diagrams

Sizing procedure:

Determine the appropriate side-stream flow (F) according to the following guidelines under normal use for each pool type.

Recreation/Lap Pool (78-85°F):	24 hour dose	F=pool volume (gal)/1,440
Therapy Pool (86-94°F):	12 hour dose	F=pool volume (gal)/720
Wading Pool (80-88 °F):	4 hour dose	F=pool volume (gal)/240
Spa (94-104°F):	2 hour dose	F=pool volume (gal)/120

Determine the appropriate Dose (D) to achieve the desired CT (Concentration X Time) of 1.6 ppm. Adjust the dose rate time down, if a heavy bather load condition is expected, but never greater than the numbers above per pool type (i.e. the spa can be divided by less than 120 but never greater than 120).

Determine the appropriate Retention Time (T) to achieve the desired CT (normally 1-3 min). Adjust time to achieve the specific goal of the system. Mixing Towers do not require Retention Time calculation.

Generator Sizing Formula: **F • D • 0.227 = Grams per hour Ozone Required**

Contactor Sizing Formula: **F • T = Size of Retention in gallons**

Example

100,000 gallon lap pool to be dosed for a CT of 1.6:

Calculate Side Stream Flow (F):	**100,000 (gal) / 1,440 (min) = 69 GPM**
Calculate Ozone Generator Size	**69 GPM • 1.6 • 0.227 = 25.0 g/hr**
Calculate Contact Tank Size	**69 GPM • 2 min = 138 gallons retention**

Practical System Recommendations **See Appendix B**

D. Ozone Monitoring (Aqueous Ozone)

Pool recirculation water shall be monitored with an ORP (oxidation reduction potential) meter that will control the ozone generator in the event the ORP meter reading exceeds 900 mV.

EXCEPTION: An ORP meter is not required when the ozone generating equipment utilizes an ozone removal system. **See C**

E. Ozone Monitoring (Gaseous Ozone) Indoor Equipment Room See B. *Ozone Generating Equipment Located Indoors*

F. Ozone Monitoring (Gaseous Ozone) Above Pool Water Surface

Gaseous Ozone concentration shall not exceed 0.1 ppm in the air space, within 6 (six) inches of the pool water. At the time the ozone generating equipment is installed, again after 24 hours of operation and annually thereafter, the air space within 6 (six) inches of the pool water shall be tested to determine compliance with this requirement. Results of the test shall be provided to the local enforcing agency for review.

Note

Hand-held Digital gaseous ambient monitors are preferred.

Detector tubes with volumetric pumps are acceptable.
These are 'grab samples' and give only an estimate of the concentration at the time the measurement was made. The tubes CANNOT be re-used. Detector tubes have a limited shelf-life (one or two years) and shall be replaced at regular intervals (per manufacturer's instructions).

Appendix A

Material Selection

The strong oxidizing power of ozone shall be considered when choosing materials for pipes, valves, gaskets, pump diaphragms and sealant. Materials for water piping, tanks and other vessels shall be resistant to corrosion and chemical attack. Materials for ozone gas conveyance shall be nearly inert.

Suitable materials and their uses are:

1. For Ozone/Air or Ozone/Oxygen:

Concentrations above 2500 ppm (0.4 % wt)

- PTFE, FEP (Teflon®) – tubing, o-rings, or ozone cell materials
- PVDF (Polyvinylidene Fluoride), Kynar® (Pennwalt patent) – tubing, injection, check valves
- Stainless Steel, grade 316L – tubing or ozone cell materials
- Glass and most ceramics – ozone cell materials
- Aflas® – seals, o-rings, gaskets

Concentrations below 2500 (in addition to those above)

- Viton® – tubing, seals, o-rings
- Kel-F® – seals & o-rings

Note: Stainless steel tubing shall only be used when the feed-gas is dried to a dew point below -60° C and where no chance of water ingress exists. Corrosive acids formed in moist air will corrode the pipes from the inside.

2. For dissolved Ozone in Water (in addition to all those listed above):

- PVC or CPVC (schedule 40 or 80)
- EPDM (Ethylene - propylene terpolymer)
- PVDF (Polyvinylidene Fluoride), Kynar® (Pennwalt patent)

3. Gaskets and O-rings

- Aflas®, Kalrez®, and Teflon® are acceptable gasket materials for both gas and aqueous seals.
- Viton®, EPDM, and “Red Silicon” do not provide sufficient resistance to deterioration at ozone concentrations above 1.5% (gaseous) but work well in aqueous ozone solutions. If used for gaseous application these shall only be used in static seals and replaced regularly.

4. Joint Sealing

- Properly applied Teflon tape may be used successfully for sealing joints. However, threaded fittings shall be avoided where possible. Hypalon® and silicone sealers which do not contain rubber filler are also successful.

Appendix B

Practical System Recommendations

- Side-stream sized for turnover appropriate for pool activity (see recommendations)
- Venturi injection vacuum operation
- Contacting system to provide retention time necessary to achieve desired CT
- Degassing of undissolved gaseous ozone
- Destruction of undissolved gaseous ozone
- ORP controller/monitor to maintain maximum 900 mV after side-stream return
- Ambient ozone monitor in the pool equipment room