The Carolina’s
Pool/Spa Operator’s
Handbook

To be used in The Pool Professor Pool Operator Course’s.
Part 1

Carolina Swimming Pool and Spa Rules and Regulations
North Carolina Public
Swimming Pool Statute Highlights

This outline is no substitute for a complete understanding of the State of North Carolina Public Swimming Pool Statutes, but an attempt to highlight the main points included in the statutes. To be used only as a learning tool for students of Roy Fielding. All page number refer to the North Carolina General Statutes 130A-280 through 130A-282 Section 2500 Public Swimming Pools. All students should check the box in front of each item as it is reviewed and questions answered. Sign and date after checking all boxes. State codes on-line at http://www.deh.enr.state.nc.us/ehs/quality/poolinks.htm.

**All Pools**
- All public swimming pools must be permitted.
- Water distribution systems shall be protected against back flow.
- Make up pool water shall be supplied through an air gap or approved back flow prevention method.
- New pool construction or remodeling must be approved.

**Safety Equipment**
- A light, strong pole not less than 12 feet long, including a securely attached hook. (Non-telescopic)
- US Coast Guard Approved Ring Buoy attached to rope exactly 50 feet long or exactly 1 ½ times the width of the pool (whichever is less) and 1/4 inch or greater in diameter. Note below if you have lifeguards.
- A rescue tube or rescue can shall be accepted when accompanied by a lifeguard who has been trained to use it properly.
- The above items are called a unit of lifesaving equipment. Any pool greater than 3000 sq. ft. must have two units.

- The telephone shall be permanently affixed to a location inside the pool enclosure or outside the enclosure within 75 feet of a bather entrance. The telephone shall be visible from within the pool enclosure or a sign shall be posted indicating the location of the emergency telephone. A sign with clearly legible letters shall be posted at the telephone providing dialing instructions, address of the pool location and the telephone number.
- Effective for state 4/1/00 (Mecklenburg County) Phone must be in the pool area and instructions stating "IN CASE OF EMERGENCY DIAL 911" must be posted. Effective 5/18/99

**Signage** (the facility must have at least this sign age permanently mounted and visible)

**Pools with NO lifeguards**
- “WARNING-NO LIFEGUARD ON DUTY” (must be 4 inches in height)
- “CHILDREN SHOULD NOT USE THE SWIMMING POOL WITHOUT ADULT SUPERVISION”
- “ADULTS SHOULD NOT SWIM ALONE”

**Wading pools with NO lifeguards**
- “WARNING NO LIFEGUARD ON DUTY” (must be 4 inches in height)

**Wading pools with a single drain**
- “WARNING To prevent serious injury do not allow children in wading pool if drain cover is broken or missing” (½ inch lettering)

**All Pools**
- No Pets permitted in pool area.
- No Glass containers in pool area.
- No diving in 5 feet of water or less at appropriate areas.
- Bathers use showers and toilets before entering pool
- All public swimming pools shall post a sign visible upon entering the pool enclosure directing pool users to shower before entering the pool.
- (MC) Pool Permit shall be posted in a location that the public can see it upon entry.

**Spas**
- It is mandated that sign age be mounted adjacent to the entrance and letters ½ inch in height.

- CAUTION
- Pregnant women; elderly persons, and persons suffering from heart disease, diabetes, or high or low blood pressure should not enter the spa/hot tub without prior medical consultation and permission from their doctor;
- Do not use the spa/hot tub while under the influence of alcohol, tranquilizers, or other drugs that cause drowsiness or that raise or lower blood pressure;
- Do not use alone;
- Unsupervised use by children is prohibited;
- Enter and exit slowly;
- Observe reasonable time limits (that is 10-15 minutes), then leave the water and cool down before returning for another brief stay;
- Long exposures may result in nausea, dizziness, or fainting;
- Keep all breakable objects out of the area.
- Showers required before using spa and prohibiting oils, body lotion, and minerals in the water.
- A sign shall be posted indicating location of nearest phone and emergency phone numbers.

**Depth Markers**
- Markers must be at least 4 inches in height, color contrasting and non skid. They must state unit of measure in feet or ft.
- On the deck and on the vertical wall where it can be seen from within the pool at the pool's waterline.
- Located at maximum and minimum depths.
- At the transition point from shallow to deeper water. In less than 5 feet of water it must say NO DIVING in 4” letters or using a 6 inch by 6 inch tile with the international symbol in red & black on a white background no more than 25 feet apart.
- Depths in diving area.
No pool water should be greater than 90 degrees Fahrenheit if you have a heater.
No spa water should be greater than 104 degrees Fahrenheit.
No water from showerheads and lavatories should be greater than 110 degrees Fahrenheit.

Water Quality (when the pool is open for use)
- pH must range from 7.2 up to 7.8
- Free chlorine at least 1.0 ppm or Bromine at least 2.0 ppm or Biguanide at least 30 to 50 ppm
- Children activity pools, wading pools and interactive play features 2 ppm
- Water depth of 4 feet or greater the starting block should be no more than 30 inches above water surface.
- Water depth less than 3.5 feet no starting blocks allowed.

Bather Loads
- Depth of 5 feet or less-1 person per 15 square feet of water surface area.
- Depth of greater than 5 feet-1 person per 24 square feet of water surface area.
- 300 square feet for each diving board should be subtracted to determine a bather load.
- A spa-1 person per 10 square feet of water surface area.

Turnover Rate
- Pool 6 hour
- Wading Pool 2 hour
- Spa 30 minute

Starting Blocks
- Water depth less than 3.5 feet no starting blocks allowed.
- Water depth 3.5 feet and less than 4 feet no more than 18 inches above the waters surface.
- Water depth of 4 feet or greater the starting block should be no more than 30 inches above water surface.
- Starting blocks must be removable.
- Starting platforms used for racing starts during competition shall be secured from use when the pool is open for use.

Equipment
- You must have a spare hair and lint basket for a recirculation pump.
- A flow rate indicator must be installed or present.
- Pumps, filters, skimmer and chemical feeders must be NSF listed if less than 3 hp.
- Mechanical ventilation for all indoor pools
- Adequate lighting needed for indoor pools and pools used at night. Ten (10) foot candles 6 inches above the deck.
- A maximum 15 minute timer switch for all spa hydrotherapy turbulence systems, placed so you must exit spa to reset.
- All ladders, stairs, railings, slides, diving boards, fumes . . . etc. must be in good working order or repair.
- The circulation system shall operate 24 hours per day during operating season.

Other
- Adequate fencing with self-closing and positive self-latching gates. Four(4) feet in height
- No algae present
- Decks must have good drainage, free of trip hazards(1/2 inch offset), and unobstructed.
- Drain covers must be in place, good condition and securely attached.
- Floating debris shall be removed from the pool water.
- All chemicals shall be stored in a clean, dry, well-ventilated area, and so the chemicals cannot interact.
- Automatic chlorinator or brominator with NSF (National Sanitation Foundation) seal.
- Test Kit appropriate to disinfectant type.
- Pump and motor must have data plate.
- Operating instruction sheets must be posted in filter room.
- flow meter(s) provided on return lines of all recirculation systems. Accurate within 10% of true
- Valves must be tagged.
- Sight glass must be provided on backwash line.
- Spas constructed after 4/1/2000 must have drains 3 ft. apart or on two different planes.
- Outdoor pool deck clear walking space of six(6) feet in under 1600 sq. ft., eight feet if 1600 sq. ft. or greater.
- Indoor pool deck clear walking space of five(5) feet at all points. Wading pools and spas four(4) feet.
- The chemical feeders must automatically turn off when the pump is not running

Serious Violations
The Health Department will suspend or revoke an operation permit in any of these items are present.
- Insufficient pool disinfectant in the water, (1 ppm chlorine 2 ppm bromine).
- The pool’s recirculation pump not running.
- Main drain cover(s) off, not secured, or damaged.
Main drain or bottom of pool not visible.
Pools with temperatures higher than 90 degrees F., or spas with temperatures higher the 104 degrees' F.
Missing safety equipment.
pH not 7.2-7.8
A non-properly working emergency telephone
Broken glass in or around pool.(nothing in codes)
Electrical violations.(nothing in codes)

Repair or Replacement
- Repair of equipment is allowed as long as the repair results in a comparable operation.
- If replacement of equipment is different from repair you must submit documentation to the health department.

Counties
- There maybe rules and regulations that individual counties may have that supercede the state code. An example would be that Mecklenburg County requires lifeguards at certain permitted pools. It is up to you know if your county has any other guidelines you must follow besides the state’s code.

- Type “A” pools are municipality, community organization, neighborhood association, school, college, university, athletic club, institutional facility, country club, or similar facility.
- Type “B” hotel, motel, apartment, condo, or similar facility.
- Type “C” any public spa
- Type A pools with a pool depth of five feet or less shall provide, on the premises, a lifeguard or other person trained in lifesaving techniques who regularly surveys the pool area, but is not required to remain in the pool area. A suitable alarm shall be provided at pool side to summon such lifeguard or other person to the pool area in the event of an emergency.
- Type A pools with a pool depth greater than five feet shall provide a lifeguard or lifeguards trained in lifesaving techniques at pool side at all times when the pool is open for operation.
- Type B and C pools lifeguards are not required, however no pool regardless of type shall be used when a lifeguard or other person is not person.
- A telephone shall be in the pool area, capable of directly dialing 911. Instructions stating “IN CASE OF EMERGENCY DIAL 911” and the name and address of the facility must be clearly posted on or near the phone.

Inspection Form
The new inspection form is based on a demerit system

- 2 point items - Construction requirements applicable to pools constructed after May 1, 1991. These violations should be corrected as quickly as possible, and must be addressed if a facility is remodeled.
- 4 point items - These are requirements applicable to all pools and are potentially more serious than the 2 point items. Violations that are not corrected or which are repeated could lead to permit suspension.
- 6 point items - These are serious violations that can result in an imminent threat to life or irreparable harm to the environment. A permit will be suspending whenever there is a violation of a 6 point item. The facility will be required to close until a reinspection indicates corrections have been made and the permit can be reinstated.

Other Statutes:
The pool operator shall take the following steps to manage fecal accidents:

1. Direct everyone to leave all pools into which water containing the feces is circulated and do not allow anyone to enter the pool(s) until decontamination is completed;
2. Remove as much of the fecal material as possible using a net or scoop and dispose of it in a sanitary manner;
3. Raise the free available chlorine concentration to 2 ppm at a pH of 7.2 to 7.5 and test to assure the chlorine concentration is thoroughly mixed throughout the pool;
4. For accidents involving formed stools, maintain the free available chlorine concentration at 2 ppm for at least 30 minutes before reopening the pool. For accidents involving liquid stools increase the free chlorine residual and closure time to reach a CT inactivation value of 15300 then backwash the pool filter before reopening the pool. CT refers to concentration (C) of free available chlorine in parts per million multiplied by time (T) in minutes.

(a) No public swimming pool shall operate with a single outlet to any pump. Where flow from a single drain is balanced with flow from a surface skimmer, the skimmer valve shall be kept in the open position and secured against tampering. Effective April 1, 2006 all public swimming pools with a single main drain shall be protected from potential bather entrapment by a safety vacuum release system installed on the drain piping and single drains smaller than 12 inches in diameter shall be protected by an anti-entrapment drain cover meeting ANSI/AMSE A112 Standard which is incorporated by reference...........
(b) Structures covering swimming pools, including temporary domes, shall be constructed to maintain a vertical clearance of at least seven feet from all parts of the required clear walk space. There shall be at least five feet of clear walking space around any diving board, handrail, slide or other permanent structure installed on a swimming pool deck.
(c) Public swimming pools constructed after April 1, 2004 shall provide a separate room for storage of pool chemicals.

New North Carolina codes should be coming out in early 2010 check the website at http://www.deh.enr.state.nc.us/ehs/pti_pools.htm


**Inspection of Swimming Pool**

<table>
<thead>
<tr>
<th>Points Deducted (Circle)</th>
<th>* Indicates critical item (6-point demerit)</th>
</tr>
</thead>
</table>

**WATER QUALITY: (2535)**

1. Water clear enough to clearly see bottom of pool and pool drain 
   
   free chlorine = _______ (at least 1.0 ppm or 2.0 ppm where required); 
   
   bromine = _______ (at least 2.0 ppm); or 
   
   biguanide = _______ (30 to 50 ppm). 

2. Disinfectant residual provided by:
   
   *4. Water temperature of heated pool ______°F; does not exceed 90°F (swimming pool) or 104°F (spa) 
   
   5. Daily written records of water quality and test kit kept on site 

**POOL MAINTENANCE:**

6. Main drain covers secured and in good repair, no suction hazard. Single 
   
   drains protected by April 1, 2006 (2537, 2539). 

7. Pool walls and floor kept clean, free of debris and in good repair (2537). 

8. Surface skimmers (with weirs, baskets and covers) or gutters clean, in good 
   
   repair, and functioning properly, no floating debris (2518, 2537) 

9. Depth markings and no diving markers or signs visible and properly located 
   
   (2523, 2537) 

10. Safety ropes with floats and contrasting color bands provided at shallow area 
   
   break points (2515, 2523) 

11. Diving equipment, ladders, steps and handrails properly placed, in good repair 
   
   (2517, 2521) 

12. Inlets and other fittings in place and in good repair (2537) 

13. Contrasting band on steps and benches (2521, 2516, 2532) 

14. Spa timer working properly (2537) 

**PREMISES:**

15. Body hook and ring buoy with throw rope or lifeguard with rescue tube 

   provided and properly located (2530, 2537) 

16. Fence or barrier with self-closing, self-latching gates properly constructed and 
   
   maintained (2528, 2537) 

17. Decks unobstructed, properly drained, free of trip hazards (2522, 2537) 

18. Lifeguards present or warning signs posted (2530) 

19. Signs prohibit glass containers or pets in pool area (2530) 

20. Caution signs posted at hot water spas (2532) 

21. Pool and deck lighting provided at pools that operate at night (2524, 2537) 

22. Emergency telephone provided (2530) 

**EQUIPMENT ROOM:**

23. Chlorine or bromine automatic feeders that meet NSF Standard 50 (2535) 

24. Approved pump, filter, and flow meter operating properly (2518, 2519) 

25. Equipment and chemicals kept in a dry, well-ventilated enclosure (2533, 2534, 2537) 

26. Valves and pipes identified by color codes or labels (2518) 

27. Filter backwash discharged through an air gap (2513) 

**DRESSING AND SANITARY FACILITIES:**

28. Bathhouse or rest rooms accessible; shower sign posted (2526) 

29. Required fixtures provided, clean, and in good repair (2526) 

30. Approved water source, no cross connections (2512) 

31. Sewage disposed of in a properly operating sewage system (2513) 

32. Floors smooth, slip-resistant, kept clean (2526) 

33. Hose bibs and floor drains provided (2526) 

**Report received by:**

[Check boxes for Yes or No]

**Disposal:**

- [ ] Yes
- [ ] No

**Purpose:** General Statute 130A-282 requires the Commission for Health Services to adopt rules governing Public Swimming Pools. 15A NCAC 18A. 2511 specifies the contents of an inspection form to record the results of inspections. This form is developed to be used in making inspections of public swimming pools, spas, wading pools and water recreation attractions. Preparation: Local environmental health specialist shall complete the form every time they conduct an inspection. Prepare an original and two copies for:

1. Original to be left with the responsible person.
2. Copy for the local health department.
3. Copy for the Environmental Health Services Section, Division of Environmental Health. Disposition: This form may be destroyed in accordance with Standard 7, Inspection Records, of the Records Disposition Schedule published by the NC Division of Archives and History. Additional forms may be ordered from: Division of Environmental Health, 1630 Mail Service Center, Raleigh, NC 27699-1630.
SAFETY AND DEPTH MARKING REQUIREMENTS
2004 Rules Governing Public Swimming Pools

DEPTH MARKINGS
Placement:
1. On the vertical wall of the pool and on the edge of the
   deck next to the swimming pool
2. At points of maximum and minimum depths
3. At the transition point
4. Separate markings for Diving Area depths
5. Not greater than 25 feet apart

Minimum Requirements:
1. At least 4 inches high
2. In contrasting color to background; slip resistant finish
3. Must contain the word “feet” or abbreviation “ft”

NO DIVING
In areas where water is less than 5 feet deep:
1. On the pool deck
2. In contrasting color to background
3. No greater than 25 feet apart

Minimum Requirements:
1. “No Diving” in letters at least 4 inches high
   OR
2. 6 inch by 6 inch international symbol in red & black
   on a white background

REQUIRED SIGNS
Swimming Pools
☑ “WARNING - NO LIFEGUARD ON DUTY”
☑ “CHILDREN SHOULD NOT USE THE SWIMMING
   POOL WITHOUT ADULT SUPERVISION”
☑ “ADULTS SHOULD NOT SWIM ALONE”
☑ The location of the emergency phone if not clearly visible
   from the pool
☑ A sign prohibiting pets and glass containers
☑ Pool Closed sign (for use whenever the pool is closed)
☑ Dialing instructions, address of the pool location and
   telephone number
☑ Sign directing pool users to shower before entering pool

Swimming Pools Minimum Requirements:
letters at least 4 inches high
letters at least 1 inch high
letters at least 1 inch high
no minimum letter size required
no minimum letter size required
no minimum size or wording
Legible, located at the emergency
phone
Visible upon entering the pool

Wading Pools
☑ “WARNING - NO LIFEGUARD ON DUTY”
☑ The location of the emergency phone if not clearly visible
   from the pool
☑ No depth markings are required
☑ Pool Closed sign (for use when closed)
☑ “WARNING To prevent serious injury do not allow children in
   wading pool if drain cover is broken or missing”
☑ Sign directing pool users to shower before entering pool

Wading Pools Minimum Requirements:
letters at least 4 inches high
no minimum letter size required
no minimum size or wording
letters at least ½ inch high (if pool has only
one main drain)
Visible upon entering the pool

Spas
☑ The location of the emergency phone if not clearly visible
   from the pool
☑ No depth markings are required
☑ Sign requiring a shower for each user and prohibiting
   oils, body lotion, and minerals in the water
☑ Pool Closed sign (for use when closed)
☑ “CAUTION”
“- Pregnant women; elderly persons, and persons suffering from
   heart disease, diabetes, or high or low blood pressure should not
   enter the spa/hot tub without prior medical consultation and
   permission from their doctor;
- Do not use the spa/hot tub while under the influence of alcohol,
   tranquilizers, or other drugs that cause drowsiness or that raise or
   lower blood pressure;
- Do not use alone;

Spas Minimum Requirements:
no minimum letter size required
no minimum size or exact wording
no minimum size or wording
letters at least ½ inch in size
- Unsupervised use by children is prohibited;
- Enter and exit slowly;
- Observe reasonable time limits (that is, 10-15 minutes),
   then leave the water and cool down before returning for
   another brief stay;
- Long exposure may result in nausea, dizziness, or fainting;
- Keep all breakable objects out of the area.”
Part 2

Risk Management for Aquatic Facilities
### Check List for Aquatic Liability

<table>
<thead>
<tr>
<th>The Aquatic Professional</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>1. Be currently certified in as many aquatic areas as possible.</td>
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<tr>
<td>2. Attend conferences, courses, workshops, seminars in aquatics regarding risk management, administration, water chemistry, etc.</td>
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<td>3. Maintain personal skill levels to current certification standards.</td>
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<td>4. Keep up-to-date with current aquatic trends thru magazines, journals, books, and Internet information.</td>
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### Aquatic Facility Design

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>1. Correct any identifiable safety problems due to the facility.</td>
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<tr>
<td>2. Post rules and regulations required by state and local codes, and additional ones dictated by the facility design. Make sure that all rules and regulations are enforced at all times.</td>
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<tr>
<td>3. Follow all codes regarding placement and size requirements for depth markings.</td>
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<td>4. Use universal sign age and multilingual signs to warn of potential dangers.</td>
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### Aquatic Equipment

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>1. Keep all equipment in good repair. If equipment is not repaired, and is necessary for safety, do not open the facility.</td>
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<tr>
<td>2. Follow all state and local codes regarding necessary safety equipment and standards. Be aware of changing standards of care in equipment used in lifeguarding.</td>
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<td>3. Maintain proper lighting at indoor and outdoor night swimming pools.</td>
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<td>4. Maintain equipment data sheets and maintenance records.</td>
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<td>5. Develop and follow proper procedures for using aquatic equipment.</td>
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<tr>
<td>6. Adopt an on going maintenance plan and procedures.</td>
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<tr>
<td>Lifeguards</td>
<td>Yes</td>
<td>No</td>
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<td>--------------------------------------------------------------------------</td>
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<tr>
<td>1. Two certified lifeguards must be on duty at anytime.</td>
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<td>2. Add additional guards according to size of pool and/or bather load.</td>
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<td>3. CPR, First Aid, and life guarding certifications all must be current.</td>
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<tr>
<td>4. Bather load capacity established using state and local codes.</td>
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<tr>
<td>5. In-service training required by all current lifeguards.</td>
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<tr>
<td>6. Pool rules must be consistently applied at all times.</td>
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<tr>
<td>7. No diving allowed in less than 5 feet of water.</td>
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<td>8. Require lifeguard uniforms and whistles at all times.</td>
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<tr>
<td>9. Maintain a Blood borne Pathogens training program for aquatic staff.</td>
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<thead>
<tr>
<th>Emergency and Incident Procedures</th>
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<tbody>
<tr>
<td>1. Maintain accurate incident reports.</td>
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<tr>
<td>2. In-service training should be conducted for every potential emergency and incident at your facility.</td>
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<td>3. Have all emergency phone numbers and a emergency phone script near all facility telephones.</td>
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<td>4. Contact local EMS units to go over potential emergencies and routes for any necessary response.</td>
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<tr>
<td>5. Have written emergency response procedures for lifeguards, maintenance personnel, and other staff members.</td>
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<tr>
<td>6. Material Safety Data Sheets available for all chemicals at the facility.</td>
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<td>8. Develop a emergency action plan for hazardous materials and notify local authorities.</td>
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<tr>
<td>9. Have and use proper safety equipment.</td>
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<td>10. Maintain an on going relationship with local authorities.</td>
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Pool Water Chemistry

1. Maintain a filtration rate of a 6 hour turn over for pools, 2 to 4 hour turn over for wading pools, and 30 minute turn over for spas.

2. Maintain swimming pool water temperature between 78 and 88 degrees F, and spas should not exceed 104 degrees F.

3. Perform the Langelier Saturation Index for proper water chemistry balancing.

4. Maintain indoor pool air temperature 3 degrees F above water temperature.

5. Bacteriological water tests performed weekly.


7. Start each season with new test reagents.

8. Follow water test kits procedures exactly.

9. Close swimming pool if the bottom cannot be seen clearly.

10. Maintain a minimum free chlorine residual of 2.0 ppm for pools and 3.0 ppm for spas. pH readings should be maintained between 7.4 to 7.6.

Facility Manual

1. Maintain and update as necessary a complete operation manual for the aquatic facility.

2. Manual should contain all policies related to staff personnel.

3. Operational procedures for all aspects of the facility.

4. Facility forms for logging information on operation.

5. Complete facility safety plans and programs.

Americans with Disabilities Act

1. Meet all standards related to ADA and you facility.

2. Conduct employee training related to ADA policies.
For Aquatics Staff:
Twelve Steps for Prevention of Recreational Water Illnesses (RWIs)

The following information about recreational water illnesses and ways to help prevent them is for people who own, manage, operate, or work at pools, waterparks, hot tubs, and spas.

www.cdc.gov/healthyswimming
How can you protect swimmers from recreational water illnesses (RWIs) without restricting access and enjoyment? Consider how pool operators deal with other risks that have been identified at the pool. Problems that have been on deck for years include drowning, injuries, bad weather, and blood spills. Pool operators have adopted risk management strategies that rely on state-of-the-art safety equipment and intensive training of staff. Lifeguards are trained in drowning prevention, rescue, first aid, and policies related to weather use and injury prevention. RWI prevention is no different. It will take a combination of equipment and design improvements, new thoughts on pool policies and management, and critical training and education of staff. However, the responsibility for preventing RWIs does not fall on pool staff alone.

Swimmers need to be educated about the necessary behavior changes that they need to make in order to reduce the spread of RWIs. Because this is such a complex problem, pool staff, swimmers, and health departments all have a role to play in reducing the spread of RWIs.

Integrating the 12 steps for RWI prevention into your current risk management program should help reduce the risk of your pool spreading RWIs.

### 12 Steps for RWI Prevention for Pool Staff

1. **Lead your staff.**
2. **Develop partnerships.**
3. **Educate pool staff.**
4. **Educate swimmers and parents.**
5. **Maintain water quality and equipment.**
6. **Evaluate aquatic facility design.**
7. **Institute disinfection guidelines.**
8. **Evaluate hygiene facilities.**
9. **Develop a bathroom break policy.**
10. **Create a special policy for large groups of young children.**
11. **Post and distribute health information.**
12. **Develop an outbreak/emergency response plan.**
STEP 1: Lead your staff.

Every aquatic facility is different with distinct priorities that have to be juggled on a daily basis while working within limitations on staff and resources. However, all aquatic facilities make safety and health a top priority.

Making a choice to integrate an RWI protection plan into an existing facility risk management plan is the single greatest decision you can make to protect swimmers from RWIs. Take the lead, outline your vision, show your commitment to your staff, and put yourself at the forefront of the aquatics field. Decide that RWI protection is a priority; back it up with resource investment and commitment, and that will set the tone for the rest of the staff.

Determine which of the Healthy Swimming recommendations are feasible to implement in your facility with available resources.

Investing heavily after the outbreak occurs, a common occurrence, is great but it would have been better for the public’s health and more cost-effective if this were done before the outbreak occurred.

STEP 2: Develop Partnerships

Building a communication bridge to your health department and other aquatic facilities is a great way to get information about other outbreaks occurring in your community. If you start to hear about outbreaks associated with other pools, daycares, schools, etc., where your swimmers attend, then take proactive measures and increase vigilance to protect your pool. Increase education of staff, swimmers, and visiting daycare groups. If a pool closes because of a suspected outbreak, that does not mean that all of the swimmers should descend on your pool without giving them some education about RWI prevention. Work with your health department to get the word out when a potential RWI outbreak is occurring. Remind them that one of the messages to send out whenever a diarrheal outbreak is occurring is “don’t swim when ill with diarrhea.” Use your communication networks and the media to alert patrons that they should not be swimming if they are ill with diarrhea. Protect your facility, make the contacts early, and build a communication network so that you are aware of the health status of your community at all times.
STEP 3: Educate pool staff.

1. Ensure that the pool operator, at a minimum, has taken part in a standardized training course given by aquatics professionals.

2. Integrate the steps for Healthy Swimming (see poster on next page) into staff training.

3. Promote good hygiene and safety around the pool by knowing the Steps for Healthy Swimming.

4. Inform parents that unhealthy behaviors at poolside and elsewhere are no longer acceptable. Parents told CDC that they wanted to be able to rely on the lifeguards for help and enforcement.

5. Ensure that all staff know the critical role of water testing, proper testing methods, the importance of dual chlorine and pH control (fact sheet at www.cdc.gov/healthyswimming/ph_chlorine.htm) and how to respond if disinfectant levels are not adequate.

6. Make sure that staff can explain, in a way that is inoffensive and acceptable to parents, why behaviors such as using public tables and chairs for diaper changing is a health risk. This may require that an older, more experienced staff member be assigned to the kiddie pool.

7. Distribute educational materials, such as Healthy Swimming aquatics staff newsletters, fact sheets, and Q & A's.
STEP 4: Educate swimmers and parents.

1. Educate your season pass holders. You may choose to begin by educating them first since they may feel more ownership of the facility and want to make the facility as safe as possible.

2. Educate your daily patrons. You might hand out prevention messages (Steps for Healthy Swimming or CDC brochure) as patrons enter the pool or park area.

3. Remember that people care about their health, so a lead-in might be: “To ensure the health and safety of all our visitors, we ask that you remember to follow these easy Steps for Healthy Swimming.”

4. Consider implementing a short safety and RWI orientation for larger groups before they enter the pool complex. This is especially important for groups with young children (see step ten).

**They did it... Why can't you?**

The Air Force Outdoor Recreation Program operates 186 swimming pools around the world. We needed to stay proactive in keeping our pools a safe and fun place for our customers. At the National Aquatics Conference, CDC gave an excellent presentation on RWIs and the Healthy Swimming Project. As a result, we issued mandatory guidance to all of our installations addressing participation in the Healthy Swimming Project. CDC’s materials help the staff understand the need for this initiative. The materials are high quality and easy to use. This is a great example of how the Internet can really help get materials into the hands of the front-line pool operators. We had a very successful swim season in 2002 so any concerns that we might "scare away" customers by sharing information on RWIs are unwarranted.

—Phillip Heeg, Manager, Air Force Outdoor Recreation Program

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**Six Steps for Protection Against Recreational Water Illnesses (RWIs)**

**PLEASE**
- don’t swim when you have diarrhea.
- don’t swallow pool water.
- practice good hygiene. Shower with soap before swimming.
- take your kids on bathroom breaks or check diapers often.
- change diapers in a bathroom or at a diaper changing area and not at poolside.
- wash your child thoroughly especially the rear end) with soap and water before swimming.

For more information visit: [www.cdc.gov/healthyswimming](http://www.cdc.gov/healthyswimming)

*Poster is available at [www.cdc.gov/healthyswimming](http://www.cdc.gov/healthyswimming)*
STEP 5: Maintain water quality and equipment.

Keep the chemical feed equipment and chemicals at optimal levels within state and local government regulations.

This includes maintaining the disinfectant at regulated levels, **usually 1-3 ppm**; optimal pH (7.2-7.8); alkalinity (80-120 ppm); calcium hardness (200-400 ppm), and total dissolved solids (below 2500mg/liter).

As you know, poor pH control can compromise chlorine’s effectiveness as a disinfectant. Make sure all of your staff realize this. Remember that maintaining recommended chlorine and pH levels will prevent most bacterial outbreaks such as those caused by *E. coli* O157:H7.

When germs get into the scum (biofilm) layer, they can be protected from disinfection. Scrubbing the pool or spa to break up that scum layer is important. Don’t let germs take up residence in your pool or spa.

Be sure to monitor chlorine regularly where the chlorine is needed—at poolside. You should be able to prevent waterparks, pools, or hot tubs from running out of chlorine through regular monitoring, and pumphouse and systems checks.

Ensure regular and thorough maintenance of the recirculation and filtration equipment to provide maximum filtration.

<table>
<thead>
<tr>
<th>Water Quality</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Chlorine Disinfection Eye Irritation Skin Irritation</td>
<td>&gt; 8.0</td>
</tr>
<tr>
<td>Most Ideal for Eye Comfort and Disinfection</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>7.2</td>
</tr>
<tr>
<td>Eye Irritation Skin Irritation Pipe Corrosion</td>
<td>&lt; 7.0</td>
</tr>
</tbody>
</table>
STEP 6: Evaluate aquatic facility design.

Some pools and waterparks have already started to redesign their facilities for the purpose of illness protection.

If you are building a new waterpark, get feedback from your industry colleagues and public health experts about the safety and protection features you need to consider in the design stage.

Pool designers will respond to you, their customer, if you are clear that your public health needs are a high priority and you consider it an investment in safe operations.

Evaluate your filtration system.
If your kiddie pool filtration system is connected with other pools, fecal contamination can be dispersed from the kiddie pool to the other pools. The best situation is one in which there is a separate filtration system for the kiddie pool.

Increasing the water turnover rates in kiddie pools may decrease the length of time that swimmers are exposed to contaminating germs. This decision needs to be made in collaboration with your state and local regulators and design consultants to avoid causing suction injuries. This may require installation of antivortex drain covers (with no top openings and automatic cut-off valves) or other technology. When it comes to the spread of some illnesses, filtration can help but, remember it takes substantial time to completely filter the pool.

Evaluate your form of disinfection.
There is a great deal of interest in new technologies that disinfect pool water such as ozone, ultraviolet (UV) irradiation, and mixed oxidants.

They look promising. Seek out the experts for the latest information but keep in mind that you are still going to need some residual disinfectant in the pool when using ozone and UV. Dropping disinfectant in the pool may put swimmers at greater risk if the pool becomes contaminated.

Evaluate your hygiene facilities (toilets, diaper-changing stations, showers).
- Are there adequate numbers?
- Are they safe?
- Are they close to where they are needed?

Address these issues in the design phase if possible. Your pool will continue to be used as a restroom if you are not proactive in assuring that patrons have what they want. Down the drain versus in your pool is a major RWI prevention measure. See 'Step 8' for more information on hygiene facilities.
STEP 7: Institute disinfection guidelines.

Even if you are not required to do so, have a written fecal accident response policy and keep records of all fecal accidents, chlorine and pH level measurements, and any major equipment repairs or changes.

This may help you respond more efficiently to any problems. You may have little control over a toddler’s soiling your kiddie pool, but you do have control over how you document and respond to this occurrence.

Also put policies in place for responding to vomiting and body fluid spills. Check your state and local codes for existing information or CDC’s Healthy Swimming website (www.cdc.gov/healthyswimming) for guidance.

Develop training materials for staff so that they can respond appropriately, document the response, and communicate to patrons why, under some circumstances, it is critical to close the pool for some period of time.

It pays to be proactive.

For detailed disinfection guidelines go to: http://www.cdc.gov/healthyswimming/fecalacc.htm
STEP 8: Evaluate hygiene facilities.

In CDC’s parent interviews, parents uniformly said they change diapers at poolside because changing rooms were unclean, poorly maintained, and/or had inadequate diaper-changing facilities.

Here are some questions that you could ask to improve your facilities:

- Do you have an adequate number of facilities?
- Are they safe?
- Are the facilities close to the pool?
- Are the facilities well maintained (stocked and cleaned)?
- Would you walk barefoot in them as your patrons do?
- Are the diaper-changing facilities usable, safe, and close to hand-washing facilities?
- Do you have showers with warm water?

If possible, address these issues in the design phase.

Ask your patrons for feedback. Your pool will continue to be used as a restroom if you are not proactive in assuring that patrons have what they want.

If your facility is large enough, determine the utility of hiring a person just to maintain the restrooms or consider remodeling your diaper-changing stations. Both improvements may be good investments if they increase the number of parents and children who use them.

Install diaper-changing cabanas with soap and running water close by the kiddie pools. This is a great way to discourage parents from changing diapers on tables or lounge chairs. It can also help mothers who are also keeping an eye on other kids.

Although difficult, keep pushing to get swimmers to shower (yes, a soap and water, back-end shower) before using the pool. Dirt, sweat, and fecal matter should go down the drain, not into your pool.

Train staff to recognize risky behavior such as changing a child on public tables or chairs. Have them educate patrons about why this is a health risk.
STEP 9: Develop a bathroom break policy.

CDC hopes to heighten awareness about the transmission of recreational water illnesses (RWIs).

Parents will continue to want to see regular chlorine testing and appropriate disinfection following fecal accidents. Therefore, why not reduce fecal accidents by helping parents get their children to the bathroom by scheduling an hourly break for disinfectant testing and bathroom use? Staff should let patrons know that this break provides optimal timing for bathroom use. Additionally, to prevent transmission of germs, you should ensure that the bathrooms are clean, that they are stocked with toilet paper, and that they have ample soap for hand washing.

If parents ask, tell them this policy not only reduces fecal contamination but also should reduce the amount of urine in the pool that uses up disinfectant that could be killing germs. All of the combined chlorine that stings patrons’ eyes and brings in complaints could be reduced if patrons start urinating in the restroom rather than in the pool.

STEP 10: Create a special policy for large groups of young children.

If you allow large groups of diaper/toddler-aged children in the pool (e.g. from daycare centers) consider:

- Requiring RWI orientation training for the care providers and make sure they understand that your pool, like most daycare centers, also excludes children ill with diarrhea.
- Keeping diaper/toddler-aged children in the pools specifically designated for them.
STEP 11: Post and distribute health information

Consider providing signage in a conspicuous location before pool entry. Rotate this information and keep it updated.

The sign might state:

- Don’t swim when you have diarrhea.
- Don’t swallow the pool water.
- Practice good hygiene. Shower with soap before swimming.
- Take your kids on bathroom breaks or change diapers often.
- Change diapers in the bathroom and not at poolside.
- Wash your child thoroughly (especially the rear end) with soap and water before swimming.

Encourage swimmers to shower with soap and water before entering the pool. This could reduce the risk of pool contamination by removing invisible fecal matter from their bottoms. A quick rinsing over a swimsuit with cold water will not do much good.

Facility staff, managers, and home pool owners should consider having hot water available in shower facilities used by swimmers.

Post your last pool inspection report and let your customers know you intend to do your part to protect their health. Restaurants do it and many people choose to patronize the “best performers.”

The recreational water sector is not the only group that needs to participate in the educational process. Parents have told CDC that they would like to receive this message from various sources before they arrive at the pool. Public health officials have already begun to educate swimmers by making prevention messages available to the general public.
**STEP 12: Develop an outbreak or emergency response plan.**

The best advice is to be prepared. If an outbreak does occur, are you ready? Do you have a plan?

Most pool staff already have a risk management plan for injuries and drowning, but many do not have plans for managing a recreational water illness (RWI) outbreak.

- Develop a policy to follow in the event that you begin getting calls from the public, or the health department starts an investigation. Part of this plan should include a strategy to communicate with the local health department and media.
- Appoint a spokesperson to ensure that a consistent response is given to outside sources (callers, media, health department, and others), and that these sources have a clear contact person.
- Talk to your colleagues who have experience. It can be difficult if you are not ready to speak with reporters and an outbreak occurs.

- Develop a communication network. If you hear about problems let your health department know. Alert other pool operators in the community of problems as well.

- Collaborate with your local health department. This is always important, plus the investigation may indicate a source unrelated to the pool.

- Support the investigation. If the pool is the source of the outbreak, the investigation can often reveal how or why illness was transmitted. This information leads to better illness prevention strategies that can help everyone.

If there is an RWI outbreak, please let investigators know about the CDC outbreak toolkit found at: www.cdc.gov/healthyswimming/outbreak
Healthy Swimming

Fecal Incident Response
Recommendations for Pool Staff*

What do you do when you find poop in the pool?

*Check for existing guidelines from your local or state regulatory agency before use. CDC recommendations do not replace existing state or local regulations or guidelines.

- These recommendations are for responding to fecal incidents in chlorinated recreational water venues.

- Improper handling of chlorine-based disinfectants can cause injury. Follow proper occupational safety and health requirements when following these recommendations.

- **Pool Closures:** Fecal incidents are a concern and an inconvenience to both pool operators and patrons. Pool operators should carefully explain to patrons why the pool needs to be closed in response to a fecal incident. Understanding that pool closure is necessary for proper disinfection and protection of the health and safety of swimmers is likely to promote support rather than frustration. Pool closures allow chlorine to do its job — to kill germs and help prevent recreational water illnesses (RWIs).
WHAT ARE RECREATIONAL WATER ILLNESSES (RWIs)?

What is the first thing that pops into your head when you think about water safety? Drowning? Slipping? Lightning? All good answers, and all are very important. But, did you know that germs can contaminate swimming water? These germs cause RWIs that have made many people sick.

RWIs are caused by germs such as “Crypto” (KRIP-toe), short for Cryptosporidium, Giardia (gee-ARE-dee-uh), E. coli 0157:H7, and Shigella (Shi-GEL-uh).

HOW ARE RWIs SPREAD?

RWIs are spread by swallowing pool water that has been contaminated with fecal matter. How? If someone has diarrhea, that person can easily contaminate the pool. Think about it. Pool water is shared by every swimmer. Really, it’s communal bathing water. It’s not sterile. It’s not drinking water.

The good news is that germs causing RWIs are killed by chlorine. However, chlorine doesn’t work right away. It takes time to kill germs and some germs like Crypto can live in pools for days. Even the best maintained pools can spread illness.

SHOULD ALL FECAL INCIDENTS BE TREATED THE SAME?

No. A diarrheal fecal incident is a higher-risk event than a formed-stool incident. With most diarrheal illnesses, the number of infectious germs found in each bowel movement decreases as the diarrhea stops and the person’s bowel movements return to normal. Therefore, a formed stool is probably less of a risk than a diarrheal incident that you may not see.

A formed stool may contain no germs, a few, or many that can cause illness. You won’t know. The germs that may be present are less likely to be released into the pool because they are mostly contained within the stool. However, formed stool also protects germs inside from being exposed to the chlorine in the pool, so prompt removal is necessary.

SHOULD YOU TREAT A FORMED FECAL INCIDENT AS IF IT CONTAINS CRYPTO?

No. In 1999, pool staff volunteers from across the country collected almost 300 samples from fecal incidents that occurred at water parks and pools. CDC then tested these samples for Crypto and Giardia. None of the sampled feces tested positive for Crypto, but Giardia was found in 4.4% of the samples collected. These results suggest that formed fecal incidents pose only a very small Crypto threat but should be treated as a risk for spreading other germs (such as Giardia). Remember a diarrheal fecal incident is considered to be a higher-risk event than a formed-stool fecal incident.

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* 1 parts per million (ppm) or mg/L free chlorine at pH 7.5 or less and a temperature of 77°F (25°C) or higher.
What do I do about...

formed stool in the pool?

Formed stools can act as a container for germs. If the fecal matter is solid, removing the feces from the pool without breaking it apart will limit the degree of pool contamination. In addition, RWIs are more likely to be spread when someone who is ill with diarrhea has a fecal incident in the pool.

1. For both formed-stool and diarrheal fecal incidents, close the pool to swimmers. If you have multiple pools that use the same filtration system — all pools will have to be closed to swimmers. Do not allow anyone to enter the pool(s) until the disinfection process is completed.

2. For both formed-stool and diarrheal fecal incidents, remove as much of the fecal material as possible (for example, using a net or bucket) and dispose of it in a sanitary manner. Clean and disinfect the item used to remove the fecal material (for example, after cleaning, leave the net or bucket immersed in the pool during disinfection).

   VACUUMING STOOL FROM THE POOL IS NOT RECOMMENDED.

3. Raise the free chlorine to 2 parts per million (ppm), if less than 2 ppm, and ensure pH 7.5 or less and a temperature of 77°F (25°C) or higher. This chlorine concentration was selected to keep the pool closure time to approximately 30 minutes. Other concentrations or closure times can be used as long as the contact time (CT) inactivation value* is achieved (see next page).

4. Maintain free chlorine concentration at 2 ppm and pH 7.5 or less for at least 25 minutes before reopening the pool. State or local regulators may require higher free chlorine levels in the presence of chlorine stabilizers,† which are known to slow disinfection. Ensure that the filtration system is operating while the pool reaches and maintains the proper free chlorine concentration during the disinfection process.

   Establish a fecal incident log. Document each fecal incident by recording date and time of the event, whether it involved formed stool or diarrhea, and the free chlorine and pH levels at the time or observation of the event. Before reopening the pool, record the free chlorine and pH levels, the procedures followed in response to the fecal incident (including the process used to increase chlorine levels if necessary), and the contact time.

   * CT inactivation value refers to concentration (C) of free chlorine in ppm (or mg/L) multiplied by time (T) in minutes at a specific pH and temperature.

   † Chlorine stabilizers include compounds such as cyanuric acid, dichlor, and trichlor.

   ‡ Many conventional test kits cannot measure free chlorine levels this high. Use chlorine test strips that can measure free chlorine in a range that includes 20–40 ppm (such as those used in the food industry) or make dilutions with chlorine-free water when using a standard DPD test kit.

   § If pool operators want to use a different free chlorine concentration or inactivation time, they need to ensure that CT inactivation values always remain the same (see next page for examples of how to accomplish this).


diarrhea in the pool?

Those who swim when ill with diarrhea place other swimmers at significant risk for getting sick. Diarrheal incidents are much more likely than formed stool to contain germs. Therefore, it is important that all pool managers stress to patrons that swimming when ill with diarrhea is an unhealthy swimming behavior.

3. If necessary, before attempting the hyperchlorination of any pool, consult an aquatics professional to determine the feasibility, the most optimal and practical methods, and needed safety considerations.

4. Raise the free chlorine concentration to 20 ppm§ and maintain pH 7.5 or less and a temperature of 77°F (25°C) or higher. The free chlorine and pH should remain at these levels for at least 12.75 hours to achieve the CT inactivation value of 15,300.** Crypto CT inactivation values are based on killing 99.9% of Crypto. This level of Crypto inactivation cannot be reached in the presence of 50 ppm chlorine stabilizer, even after 24 hours at 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C).†† Extrapolation of these data suggest it would take approximately 30 hours to kill 99.9% of Crypto in the presence of 50 ppm or less cyanuric acid, 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C) or higher.

5. Confirm that the filtration system is operating while the water reaches, and is maintained, at the proper chlorine level for disinfection.

6. Backwash the filter after reaching the CT inactivation value. Be sure the effluent is discharged directly to waste and in accordance with state or local regulations. Do not return the backwash through the filter. Where appropriate, replace the filter media.

7. Allow swimmers back into the water only after the required CT inactivation value has been achieved and the free chlorine and pH levels have been returned to the normal operating range allowed by the state or local regulatory authority.
Pool disinfection time...

How long does it take to disinfect the pool after a fecal incident? This depends on what type of fecal incident has occurred and at which free chlorine levels you choose to disinfect the pool. If the fecal incident is formed stool, follow Figure 1, which displays the specific time and free chlorine levels needed to inactivate *Giardia*. If the fecal incident is diarrhea, follow Figure 2, which displays the specific time and free chlorine levels needed to inactivate Crypto.

**Figure 1 Giardia Inactivation Time for a Formed-Stool Fecal Incident**

<table>
<thead>
<tr>
<th>Free Chlorine Level (ppm)</th>
<th>Disinfection Time*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>45 minutes</td>
</tr>
<tr>
<td>2.0</td>
<td>25 minutes</td>
</tr>
<tr>
<td>3.0</td>
<td>19 minutes</td>
</tr>
</tbody>
</table>

* These closure times are based on 99.9% inactivation of Giardia cysts by chlorine at pH 7.5 or less and a temperature of 77°F (25°C) or higher. The closure times were derived from the U.S. Environmental Protection Agency (EPA) Disinfection Profiling and Benchmarking Guidance Manual. These closure times do not take into account “dead spots” and other areas of poor pool water mixing.

**Figure 2 Crypto Inactivation Time for a Diarrheal Fecal Incident**

<table>
<thead>
<tr>
<th>Free Chlorine Level (ppm)</th>
<th>Disinfection Time*†</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1,530 minutes (25.5 hours)</td>
</tr>
<tr>
<td>20</td>
<td>765 minutes (12.75 hours)</td>
</tr>
<tr>
<td>40</td>
<td>383 minutes (6.5 hours)</td>
</tr>
</tbody>
</table>

† At pH 7.5 or less and a temperature of 77°F (25°C) or higher.

The **CT inactivation value** is the concentration (C) of free chlorine in ppm multiplied by time (T) in minutes (CT inactivation value = C x T ). The CT inactivation value for *Giardia* is 45 and the CT inactivation value for Crypto is 15,300 (pH 7.5 or less and a temperature of 77°F [25°C] or higher). If you choose to use a different free chlorine concentration or inactivation time, you must ensure that the CT inactivation values remain the same.

For example, to determine the length of time needed to disinfect a pool after a diarrheal incident at 15 ppm, use the following formula: C x T = 15,300.

Solve for time: T = 15,300 ÷ 15 ppm = 1020 minutes or 17 hours. It would take 17 hours to inactivate Crypto at 15 ppm.

www.cdc.gov/healthyswimming
Part 3

Pool/Spa Equipment and Operation
THE RECIRCULATION SYSTEM

GENERAL
The recirculation system is best described as a type of transportation system which keeps the water constantly in motion. A recirculation pump delivers water from the pool to an equipment station where it is filtered, chemically treated, and then returned to the pool. A strong chlorine residual for disinfection and oxidation purposes is carried with the water as it reenters the pool. Each of the devices and components encountered by the pool water as it recirculates is discussed. Chlorine and pH feed may be provided after the water is filtered. This is especially applicable in cases where sand filters are used.

PIPING
Though copper pipe is acceptable, most pools use one of several types of plastic for piping and fittings. Low cost, complete resistance to corrosion, good flow characteristics, flexibility, and ease of installation make plastic practical for all pool piping. Steel piping should not be used in swimming pool recirculation systems.

DRAINS, OVERFLOW GUTTERS AND SURFACE SKIMMERS
Water for recirculation is removed from the pool through two main drainage systems.
  a. Some water is removed through the main drain at the deepest point of the pool. This enhances the removal of heavier-than-water particles such as sand, silt, etc. Main drain removal also contributes to mix and flow characteristics of the main pool water and the constantly returning water that is introduced at multiple inlets at the periphery.
  b. Some water is taken from the surface of the pool and is removed through the overflow system consisting of overflow rims or skimmers or combinations thereof. Surface water removal is important since the top few inches usually contain the highest degree of contamination due to oral and nasal discharges, airborne pollution, insects, etc.

STRAINER
  a. After removal, the water flows through a piping system to an equipment area where all the water at a single point is strained through a sieve like device, a removable (for cleaning purposes) screen on basket, often referred to as the "hair and lint strainer" or "leaf trap." This device collects leaves, hair, lint, gravel, insects, and other relatively large particles which would clog the pump impeller or other parts in the system. The use of this device reduces filter loading and generally improves overall system performance.
  b. The strainer must be checked often to prevent a progressive clogging condition. As the strainer becomes "plugged" with debris, the flow of water from the pool to the recirculating pump is impeded. Severe accumulations in the strainer prevent sufficient water from reaching the pump, causing a condition known as "cavitation" resulting in noise, vibration and erratic performance in the pump. Prolonged cavitation will result in serious damage to the pump impeller, bearings, and seal.

FILTER PLANT
Having been strained of debris, the water then flows to the filter plant for the removal of fine-particles such as dust, body oils, algae, slime, bacteria, coagulated material, etc. This filtration aids the chemical disinfection and oxidation processes which beneficially take place after the water is returned to the pool. The removal of undesirable materials is accomplished by several mechanical systems which are discussed in the remaining chapters. In the present state-of-the-art, pool filtration is achieved most commonly by particle entrapment in either (1) a bed of sand or (2) a thin cake of diatomaceous earth.

CHEMICAL FEEDERS
As the pool water flows beyond the filters it is chemically treated. Chlorine disinfecting agent is added, pH adjustment chemicals are introduced, and the treated water is returned to the pool to destroy bacteria and oxidize other undesirable solids.

INLET DISTRIBUTION SYSTEM
Reentry of pool water is governed by the location and sizing of inlets. When a swimming pool is in design stage great care is exercised to locate and size the inlets to obtain the best possible flow characteristics of the filtered and treated water. The inlet fittings are normally adjustable to control volume, velocity, and even direction in order to obtain overall system balance. The object, of course, is to provide rapid and uniform dispersion of treated water.
**Filters and Filtration**

**Filtration** is the mechanical process to remove insoluble matter from swimming pool and spa water.

**Turnover rate (TOR)** is defined as the amount of time it takes to filter the entire volume of water in the pool or spa. Most states require that pools must have a 6 hour TOR, wading pools a 2 hour TOR and spas a 30 minute TOR.

<table>
<thead>
<tr>
<th>Types of Filters</th>
<th>Media</th>
<th>Flow Rate (gpm per sq. ft.)</th>
<th>Backwash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Rate Sand</td>
<td>Sand &amp; Gravel</td>
<td>3 gpm/sq. ft.</td>
<td>12 to 15 gpm/sq. ft.</td>
</tr>
<tr>
<td>High Rate Sand</td>
<td>Sand</td>
<td>12 to 20 gpm/sq. ft.</td>
<td>12 to 20 gpm/sq. ft.</td>
</tr>
<tr>
<td>Vacuum Sand</td>
<td>Sand</td>
<td>12 to 20 gpm/sq. ft.</td>
<td>12 to 20 gpm/sq. ft.</td>
</tr>
<tr>
<td>Diatomaceous Earth (without a slurry feed)</td>
<td>D.E</td>
<td>2 gpm/sq. ft.</td>
<td>Hose off</td>
</tr>
<tr>
<td>Diatomaceous Earth (with a slurry feed)</td>
<td>D.E</td>
<td>2.5 gpm/sq. ft.</td>
<td>Hose off</td>
</tr>
<tr>
<td>Cartridge</td>
<td>Cartridge</td>
<td>.375 gpm/sq. ft.</td>
<td>Hose off and clean</td>
</tr>
</tbody>
</table>

**Water distribution** is important to make sure that filtered water is evenly placed throughout the pool. **Outlets (gutters, skimmers, and main drain)** return pool water to the filters.

**Inlets** are designed to return filtered water to the pool or spa.

**Recirculation Pumps** for swimming pools and spa are centrifugal pumps.

**Pool Valves** come in the following types: Ball, Gate, Butterfly and Float valves.

**Pressure Gauges** will allow the operator to determine when cleaning (backwashing) is needed for the filters. **Influent pressure** is the water pressure entering the filter. **Effluent pressure** is the water pressure exit the filter. This pressure is measured in **pound per square inch (psi)**. **Vacuum gauges** are basically used the same way for vacuum filter systems, but measure the pressure in **inches of mercury (in. Hg)**

**Flow Meters** are required to let the operator know the effectiveness of the recirculation system and will indicate the flow rate in gallons per minute (gpm).
Typical Swimming Pool Cross Section
Equalizer Cover

Leaf Rake

SP-1082

SP-1084
SP-1086

SP-1085-1

HAYWARD SP-1084 POOL SKIMMER PARTS

Pool Skimmers
SAND FILTERS

GENERAL
Of the two commonly used pool filter systems, the sand system is the easiest to understand. Soil is trapped in the filter bed by a combination of two processes: (1) gelatinous and mucous like substances and oils tend to cling to the grains of filter sand, and (2) solid particles lodge in the extremely small spaces and voids between the sand particles. As these two dirt collecting mechanisms work together, the filter bed stores more and more dirt and becomes increasingly dense and resistant to flow. Ultimately, adequate flow can no longer be sustained and the filter must be cleaned by backwashing.

FLOCCULATION
a. The accumulation of the gelatinous and mucous like substances referred to above is often described as flocculation. A sand bed does not become an efficient filter until a sufficient accumulation of floc (fine soil) inhibits the passage of very small solids. As a result the sand filter has to operate 8 to 16 hours before attaining its desired efficiency.

b. The formation of floc (filter efficiency) can be accelerated by adding aluminum sulphate or potassium alum to the recirculation stream ahead of the filter at the outset of the cycle. This practice is not nearly as widespread as it once was, however, because flocculation materials are not effective except at high pH. Since a high swimming pool water pH is not desirable for disinfection and oxidation reasons, many operators reject the practice. Because the filter bed will floc itself in due time, an acceptable practice is to sacrifice the first few hours of efficiency in return for the longer filter cycles which are obtained by letting the floc develop from soil in the pool.

EFFECT OF CHEMICALS
It is important to note that the dirt holding characteristics of a sand filter are also affected by the chemical treatment of the pool water. Good chlorination practice burns up many unwanted materials which would otherwise collect in the filter bed. Chlorination also breaks down soil barriers already accumulated in the filter medium, thus reopening clogged spaces and passages.

ANTHRACITE FILTRATION
Finely crushed hard coal (anthracite) can be used as a filter medium in the same manner as sand is used. It functions in the same way but is backwashed at lower velocities to prevent washing the medium to wastewater during the cleaning cycle.

SAND FILTER TYPES
Two types of pressure sand filters, rapid sand and high rate sand, are commonly used in swimming pools today; a third type, referred to as gravity sand, is used occasionally. Rapid sand is the traditional system developed many years ago; high rate sand is relatively recent technology.

RAPID SAND FILTER CONSTRUCTION
a. The typical rapid sand filter is a round steel vessel approximately 5 feet in height loaded with a 24inch-deep bed of sand supported on four layers of gravel graded to uniform size (see figure 12.1). The stratified gravel bed performs two functions in the sand filter:

1. It serves as a barrier which prevents the sand from washing through the underdrain into the pool during the filter cycle.

2. It distributes the flow of water uniformly to the underside of the sand bed during the backwash cycle.

b. The size of sand particles in the filter bed is an important consideration. If the sand is too coarse, the voids between the particles are too large to trap fine solids. If the sand is too fine, the sand bed becomes too dense for dirt to accumulate between the sand grains. The ideal sand particle size for filtering has been established as 0.4 to 0.6 millimeters.

c. A splash plate is positioned above the sand bed to baffle the incoming water and prevent a direct impingement upon the filter bed. A perforated pipe or domelike underdrain is placed in the bottom layer of the coarse gravel to collect the filtered water for recirculation. The space in the filter vessel above the filter bed is referred to as “freeboard” area and is necessary to allow for expansion of the sand bed during backwash procedure.

RAPID SAND FILTER OPERATION
a. Typically, the sand filter system on larger swimming pools is a battery of two, three, or four individual tanks piped together in order to receive relatively equal portions of the total flow during the filter cycle. This multiple cell arrangement provides an important accommodation to the backwash cycle. Since the sand filter must be backwashed at approximately four times the rate used during the filter cycle, the recirculation pump can provide the necessary backwash velocity only if the filter cells are backwashed one at a time. If the sand filter was a single vessel, a separate pump much larger than the one used for recirculation would be required for efficient backwash.

b. The diameter of the filter vessel is governed by the size of the pool and is specifically determined by the flow rate per square foot of surface area of the sand bed. The use of sand as a filter was introduced in the processing of public drinking water supplies, so the technology of sand filtration was quite naturally developed by public health agencies and the water works industry. During the development stage water was traditionally filtered at a rate of 3 gallons per minute per square foot (gal/min/ft²) of sand bed surface area. Thus, if a given system requires a total flow of 600 gal/min, a filter system has to contain 200 square feet of sand surface area. Today it is still common practice to use 3 gal/min/ft² as a standard of design and operation of swimming pool sand filters.
HIGH RATE SAND FILTER CONSTRUCTION
The typical high rate sand filter is a round pressure vessel with a special influent baffle in the top of the tank, a bed of filter sand, and a mechanical underdrain system to collect the filtered water for recirculation. The underdrain is often designed to serve as a barrier to the migration of the sand bed and as a backwash water distributor without the requirement of the stratified gravel bed which was traditionally used in the rapid sand systems.

HIGH RATE SAND FILTER OPERATION
a. The total plant size and hydraulic characteristics of the high rate system differs substantially from the rapid sand filter. Instead of operating at the traditional flow rate of 3 gal/min/ft², it operates at flow rates of 15 to 25 gal/min/ft² of filter surface area. Because the total flow requirements of a given pool can be satisfied through a sand bed of considerably smaller surface area than in the case of rapid sand systems, the physical plant of the high rate filter is much smaller as well.
b. The high rate system provides an effluent of excellent quality, which appears largely due to its increased dirt holding capacity. The high flow rate drives the dirt load deeper into the filter bed, thus increasing the dirt holding capacity of the medium. In the typical rapid sand system the primary soil load is confined to the top 2 to 4 inches of the sand bed, whereas the high rate filter collects soil through the entire depth of the sand bed.
c. The high rate filter system is normally backwashed at or near its filter flow rate of 15 to 25 gal/min/ft².

GRAVITY SAND FILTER
The gravity sand system is an early swimming pool design that has been largely outdated by the pressure system which can be installed and operated in a much smaller area. Although the sand bed functions as a filter medium in the same manner in both systems, the gravity system requires a much larger ground space than its equivalent pressure plant. Also, the backwashing procedure requires increases in both manual labor and water waste.

BACKWASH THEORY
Backwashing cleans the filter by reversing the flow and causing the water to course upward through the bed. The backwash water action tends to slightly expand the bed, causing the sand particles to tremble and scrub against each other allowing the collected soil to break free and wash out of the filter vessel to a point of disposal. In rapid sand filter systems the backwash cycle is normally continued until the backwash effluent is observed to be free of soil, a period of about 8 to 10 minutes per cell. In high rate filters, backwash is accomplished in about 2 minutes because of the greater velocity of the backwash water.

BACKWASH OPERATION
a. Backwashing the high rate filter is simple because there is generally only one tank in the system. However, the operator should understand the backwash function in the older rapid sand systems, based on several important observations.
b. The accumulation of foreign material in a swimming pool filter causes the soil to clump to some extent. Hair or lint often serves as a structure, and balls of organic material (mud balls) form and become imbedded in the top layer of sand. If backwash velocities are insufficient to wash the clumps to waste, they will work their way deeper into the filter bed creating channels which ultimately permit unfiltered water to take a path of least resistance through the medium.
c. Another undesirable result of insufficient backwash velocities is termed calcification. If the bed is not disturbed enough to expand slightly, it may eventually become encrusted with a cement like mass and become impervious to the flow of water. This phenomenon is particularly likely to occur if pH and total alkalinity of the pool water are permitted to become unreasonably high.
d. Both an inadequate backwash velocity and a backwash rate which substantially exceed 15 gal/min/sq. ft (25 gallons per minute per square ft of filter area for high rate sand filters) are undesirable. In some circumstances the full capacity of the recirculation pump will cause the sand and gravel bed to tumble and partially invert the sand layer and the layer of small gravel immediately beneath it. If this condition occurs, channeling can take place similar to that caused by the mud-balling described above. The condition can be corrected only by removing and reloading the first two strata of media.
e. As indicated in the above discussions, backwashing of the rapid sand filter system involves much more than a mere reversal of flow. The operator must establish the backwash flow rate with care to avoid the problems which result from either inadequate or excessive flow rates.

EQUIPMENT INSPECTION
Regardless of the protection methods used, the bed or the rapid sand filter should be periodically inspected. If signs of mud-balling or calcification are observed, the bed should be soaked with corrective chemicals such as acids and detergents.
Sand Filter Lateral

Sand Filter Diffuser

Sand Filter Interior
DIATOMACEOUS EARTH FILTERS

GENERAL
a. Diatomaceous earth filtration is used for swimming pool water and makes use of a dirt collecting medium which is discarded along with the dirt itself when the filter cycle is completed. Although three or four disposable media can be used in such systems, the one most commonly used is diatomaceous earth. It is therefore adopted as a term of reference to describe such filters throughout this chapter.
b. A cost comparison of different types of filters should be conducted before installing diatomaceous earth filters. These filters have a history of high maintenance and repair cost.

FILTER MEDIA
a. To the naked eye, diatomaceous earth is a fine white powder, skeleton like fossil of a very small form of plant life from prehistoric times.
b. The openings in the screen are large enough to permit the flow of water, but small enough to obstruct the passage of virtually the smallest particle of foreign material. Even droplets of viscous oil like liquids will be caught in the screen. The diatomaceous earth filter cake is therefore a highly efficient filter medium.

THE FILTER SEPTUM
All diatomaceous earth filters are equipped with septums (often referred to as the filter elements) or devices upon which the diatomaceous earth powder is collected in its cake form. The septum may be a cylindrical tube or a wafer like structure covered with a plastic or metal fabric of sufficiently fine weave to collect the filter cake. The septum is often a bundle of tubes, disks or wafers assembled to a pipe or pipe manifold which receives the filtered water and directs it through the recirculation system piping to the pool.

PRECOATING THE FILTER SEPTUM
a. The act of depositing the filter cake upon the septum is called "precoating." It involves mixing a slurry of diatomaceous earth and water, and then introducing the mixture at a point in the recirculation system which will result in the slurry eventually being deposited upon the septum.
b. The precoat slurry formula provides for a precoat cake thickness of 1/16 of an inch minimum. This is accomplished by preparing a slurry which contains 1/10 pound of diatomite powder for each square foot of septum surface area to be coated. It is good practice to mix a slurry containing 1-1/2 pounds of diatomaceous earth powder for each 10 square feet of septum surface area because some of the slurry will pass through the septum and be deposited in the pool or delivered to waste during the initial precoating of the septum.

CONTINUOUS BODY FEEDING THE FILTER
a. Because the soil is filtered out at the surface of the filter cake, the cake is soon slimed over and clogged with solids which inhibit flow. Such a condition produces very short filter cycles, making the diatomaceous earth system objectionable for this reason alone. It is possible to keep the filter cake porous and to increase its dirt-holding capacity by continuing to feed filter aid (diatomaceous earth) into the system through the process known as body feeding or slurry feeding. This involves introducing a continuous feed of diatomaceous earth filter powder into the unfiltered pool water as it approaches the filter system. By mixing the porous filter aid particles into the soiled water, the filter cake receives a mixture of particles, some of which are dirt solids, and some of which are porous diatomaceous earth particles which actually increases the dirt-collecting and dirt-holding capacity. Although body feeding causes the filter cake to swell and thicken, it increases its capacity to collect and store soil in the process, so the filter cycle is extended far beyond what would be provided if body feeding were not practiced.
b. The slurry feeding technique is variable and controlled in a highly discretionary manner by the operator. If bathing loads are heavy, with resultant heavy dirt accumulation, the operator increases the rate of body feed. As bathing loads subside the experienced operator continues the heavy feed until the heavy soil accumulation has been largely picked up in the filter. The operator then reduces the rate of feed until the need for heavy feeding is again presented. Body feeding, like chlorine feeding, is measured against demand and the rates are adjusted accordingly.

THE PHYSICAL PLANT
Understanding the functions of the filter medium and septum makes the diatomaceous earth filter plant rather easy to visualize. It may be either a closed tank which operates under pressure, or an open tank from which the water is drawn under vacuum to pump suction. In either case the system is comprised of a tank to receive unfiltered water, a septum to support the filter cake, and a pipe or manifold to collect filtered water from the septum and deliver it to the distribution system piping. In the case of the pressure type system, a crock or tank for precoating the filter is attached either to the filter itself or to the adjacent piping. Many shapes, sizes, and design configurations exist because there is a great deal of latitude with respect to septum design and collector piping arrangements

DRY FEEDER
Two types of body feeding equipment are commonly used. The vacuum diatomaceous earth filter may be equipped with a "dry" feeder which consists of a hopper containing the diatomite charge positioned over the filter cell. A vibrator or other device may be used to deposit measured amounts of diatomaceous earth directly into the filter.

SLURRY FEEDER
The more common system feeds the filter powder as a slurry. The slurry feeder consists of a tank containing a mixture of diatomite and water, a motor driven agitator or propeller to keep the diatomite in suspension, and a metering pump which draws the slurry from the tank and pumps it to the unfiltered water stream. A relatively dilute slurry is desirable.
because the diatomaceous earth particles tend to settle and pack or clog at points of low velocity in the pump, fittings, and solution tubing. A ratio of 1/2 pound of diatomite per gallon of water is probably ideal, but the ratio is not critical; much heavier slurries can be handled if the operator keeps the equipment functioning properly. Regardless of the ratio of diatomite to water, the slurry feed should be prepared daily, if possible, or at least every other day. The diatomaceous earth particle is very brittle and prolonged agitation in the slurry tank will tend to fracture the particles and greatly reduce their efficiency as a filter medium.

FLOW RATES AND FILTER SIZING
a. As in the case of the sand filter, the size of the diatomaceous earth filter is governed by the size of the pool. However, because diatomaceous earth filtration is relatively new technology, an inherited flow rate is not available to serve as a guide in sizing the filter system. Instead, the optimum flow rates have been determined from experience in the laboratory and in the field. b. Experience has shown that the filter flow rate is far more critical in the operation of the diatomaceous earth filter than in the operation of the sand system. It was noted that flow rates can be substantially increased in sand filtration without materially affecting cycles. The diatomite filter, however, gives markedly reduced filter runs as the flow rate is increased. Therefore, it has become common practice to use diatomaceous earth systems of sufficient size that they can be operated at filter flow rates of 1 to 2 gal/min/square foot of filter surface area.

GENERAL FILTER CLEANING
The diatomaceous earth filter responds hydraulically to dirt loading in the same manner as the sand filter. As the medium clogs with soil its resistance to the flow of water increases, eventually requiring the medium to be cleaned and recharged with filter powder. The manner in which the filter is to be cleaned is largely predetermined by the manufacturer of the equipment, so there is little reason to discuss the various mechanical systems and procedures which are offered commercially. It is worthwhile, however, to examine the basic differences between the vacuum and pressure type systems.

VACUUM SYSTEM FILTER CLEANING
The typical vacuum filter is an open tank. As the recirculation pump draws the water through the septum the dirt loading and buildup of the filter cake can be visually observed by the pool operator. When the vacuum gage and flow meter readings indicate that the filter should be cleaned, the pump is stopped, the filter cell is drained, and the elements are manually washed down with the high velocity stream from a garden hose. The operator should make certain that all the soiled cake has been effectively removed from the filter elements before returning the filter to service.

PRESSURE SYSTEM FILTER CLEANING
The pressure diatomite filter is normally a tightly sealed vessel which cannot be readily opened for manual cleaning. Instead, the system has a combination of devices and procedures for reversing the flow of water through the septum, to jet spray the elements, or to flex or move the elements within the vessel to assist in releasing the soiled cake, etc. Also, the pressure filter is frequently equipped with visual inspection ports to assist the operator in appraising the efficiency of the cleaning operation.
Pressure Gauge

Vacuum Gauge

Flow meter

Flow Meter
Part 4

Pool/Spa Calculations
Swimming Pool Calculations

Conversions Needed
Meters to Feet (# of meters X 3.28 = # of feet)
Yards to Feet (# of yards X 3 = # of feet)

Water Surface Area (Be sure and convert to feet)
Square or Rectangle Pool  Length (ft.) X Width (ft.) = area in square ft.
Circular Pool  Radius squared (ft.) X 3.14 = area in square ft.
Note: Radius is ½ the diameter of a circle.

Pool Volume (Be sure and convert to feet)
Square or Rectangle Pool  Length (ft.) X Width (ft.) X Average Depth (ft.) X 7.5 = volume in gallons
Circular Pool  Radius squared (ft.) X 3.14 X Average Depth (ft.) X 7.5 = volume in gallons
Note: Radius is ½ the diameter of a circle.

Balance or Surge Tank Sizing
Bather load X 20 gallons = size of tank needed in gallons

Water Loss Calculation
Number of inches of water loss X surface area (sq. ft.) X (.625) = number of gallons

Flow Rate (FR) and Filter Media Rating (FMR)
To determine flow rate in Gallons per minute - Square footage of filter X FMR = Flow Rate in gpm
To determine size of filter needed -  Flow rate (gpm) divided by FMR = square footage of filter needed

Filter Media Rating (FMR) for Carolina Pools
Swimming Pools  Pool Volume divided by 360 = Proper flow rate for 6 hour turnover (g.p.m.)
Wading Pools  Pool Volume divided by 120 = Proper flow rate for 2 hour turnover (g.p.m.)
Spas  Pool Volume divided by 30 = Proper flow rate for 30 min. turnover (g.p.m.)

Filter Sizing for Carolina Pools
High Rate Sand  15  gallons per minute per square foot of filter surface area
Rapid Rate Sand  3  gallons per minute per square foot of filter surface area
Vacuum Sand  15  gallons per minute per square foot of filter surface area
DE with slurry  2.5  gallons per minute per square foot of filter surface area
DE without slurry  2  gallons per minute per square foot of filter surface area
Cartridge  .375 gallons per minute per square foot of filter surface area

Heating Water  Number of degrees of increase in temperature (F) X Gallons of water X 8.33 = BTUs

Spa Water Change Formula  Gallons divided by 3
                        # of bathers per 24 hr

Cyanuric Acid (CYA) Correction for Total Alkalinity (TA)  TA – (CYA X .33) = Corrected Value for TA
Part 5

Pool/Spa
Water Chemistry
Proper water chemistry is essential to maintaining safe and consistent swimming pool operation. Chemicals used in swimming pools include: Disinfectants to destroy harmful or otherwise objectionable organisms; Alkalinity and pH Adjusters to maintain a consistent acid-base relationship and acid buffering capacity; Chlorine Stabilizer to prevent unnecessary loss of chlorine; Algaeicides to kill and prevent algae, and Filter Aids to help remove foreign material. Following is a discussion of various factors which affect water chemistry, how they affect swimming pools and how to use pool chemicals to restore properly balanced water chemistry.

**pH for Pool and Spa water**

pH is the single most important element in swimming pool water chemistry. It affects every other chemical balance in pool water.

pH is a measure of hydrogen ion (H+) concentration in water. It indicates the relative acidity or basicity of pool water. pH is measured on a scale of 0 (strong acid) to 14 (strong base) with 7 being the neutral pH.

In pools a slightly alkaline pH of 7.4 to 7.6 is most desirable because this range is most comfortable to the human eye and provides for optimum use of free chlorine while maintaining water that is not corrosive or scale forming.

**If pH is too low (below 7)**
- Water becomes acidic
- Chlorine residuals dissipate rapidly
- Eye irritation occurs
- Plaster walls are etched
- Metal fittings, pump impeller, heater core may corrode
- Dissolved metals may leave stains on walls
- Rapid Loss of alkalinity

**If pH is too high (above 8)**
- Chlorine activity is slowed and inefficient
- Scale formation and discoloration of pool walls
- Water becomes cloudy
- Filter is overworked
- Eye irritation may occur

**pH Adjustment**

To avoid the problems listed above, pH must be maintained between 7.2 and 7.8. The most desirable level for pH is between 7.4 and 7.6. If pH is too low - run alkali demand test if available. Raise pH by adding soda ash (sodium carbonate). Never add more than 2 lbs per 10,000 gallons in a single treatment. Be sure the pump is running when chemicals are added. Allow recirculating then retest to determine if further treatment is necessary. Caustic soda (sodium hydroxide) is sometimes used with chemical feed pumps to raise pH. If problems with low pH persist, it may be necessary to raise total alkalinity to stabilize the pH.

If pH is too high - run acid demand test if available. pH is lowered by adding muriatic acid (hydrochloric acid) or sodium bisulfate. Carefully add acid at the deep end of the pool. Try not to pour acid near pool walls or fittings. Remember: When using or diluting acids **always add the acid to the water (never add water to acid)**

NOTE: 10 lbs sodium bisulfate is roughly the same as 1 gal muriatic acid.

**Factors which affect pH:**

<table>
<thead>
<tr>
<th>Lowers pH</th>
<th>Raises pH</th>
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</thead>
<tbody>
<tr>
<td>Acid</td>
<td>Soda Ash</td>
</tr>
<tr>
<td>Gas Chlorine</td>
<td>Sodium Hypochlorite</td>
</tr>
<tr>
<td>Trichlor Chlorine</td>
<td>Calcium Hypochlorite</td>
</tr>
<tr>
<td>Dichlor Chlorine</td>
<td>Caustic Soda</td>
</tr>
<tr>
<td>Rain Water</td>
<td>Bicarbonate of Soda</td>
</tr>
<tr>
<td>Alum</td>
<td>Swimmer Wastes</td>
</tr>
<tr>
<td>Organic Litter</td>
<td>Algae Growth</td>
</tr>
<tr>
<td>Make up Water</td>
<td>Make up Water</td>
</tr>
</tbody>
</table>

**Total Alkalinity (TA)**

Total alkalinity is closely associated with pH but rather than a measure of hydrogen ion concentration it is a measure of the ability of a solution to neutralize hydrogen ions. Expressed in parts per million (ppm), total alkalinity is the result of alkaline materials including carbonates, bicarbonates and hydroxides - mostly bicarbonates. This acid neutralizing (buffering) capacity of water is desirable because it helps prevent wide
variations in pH whenever small amounts of acid or alkali are added to the pool. **Total alkalinity is a measure of water’s resistance to change in pH.**

**Total alkalinity should be maintained in the range of 80 to 120 ppm.**

If total alkalinity is too low:
pH changes rapidly when chemicals or impurities enter the water. pH may drop rapidly, causing etching and corrosion.

If total alkalinity is too high:
pH becomes difficult to adjust. High pH often occurs causing other problems such as; cloudy water, decreased disinfectant effectiveness, scale formation and filter problems.

**Raising Total Alkalinity** - Total alkalinity can be raised by the addition of bicarbonate of soda (sodium bicarbonate, baking soda). 1.4 lbs. bicarbonate of soda per 10,000 gallons will raise total alkalinity 10 ppm. In some cases, soda ash can be used to raise total alkalinity. Pound for pound, soda ash raises alkalinity 60 percent more than sodium bicarbonate and is cheaper. The problem with using soda ash to increase alkalinity is it drastically increases pH. This can cause cloudy water and scale formation. Soda ash should only be used to increase total alkalinity if you also need to increase the pH or if only small increases in alkalinity are needed. Chemical manufactures are now marketing a total alkalinity increaser which combines the effects of sodium bicarbonate and soda ash. The product sodium sesquicarbonate or sodium hydrogen carbonate affects total alkalinity more than sodium bicarbonate, but does not cause quite as much increase in pH as soda ash does.

**Lowering Total Alkalinity** - Total alkalinity can be lowered by adding muriatic acid or sodium bisulfate. Acid may be added in doses of up to 1 quart per 10,000 gallons. Total alkalinity tests and further required additions of acid can be made every 2 hours.

**Calcium Hardness:**
Calcium hardness is a measure of the dissolved calcium salts in water. Under normal conditions this should not be a problem in properly operated swimming pools. Estimates of the proper range of calcium hardness vary widely but the ideal level for plaster pool is generally considered to be about 250 ppm. If calcium hardness is very low then water may leach calcium from pool walls causing pitting of the plaster surface. Very high calcium hardness may contribute to scale formation and clouding of the water. To raise calcium hardness - add calcium chloride.

To lower calcium hardness anhydrous trisodium phosphate may be used. One pound trisodium phosphate per 10,000 gallons will lower calcium hardness 11 ppm. Use in small increments or clouding may occur. Another method of lowering calcium hardness is to simply drain off part of the pool water and dilute the remaining water with fresh make up water.

**Total Dissolved Solids (TDS)**
After a pool has been in use for a time, dissolved solids may begin to accumulate. These unfilterable solids include body wastes, suntan lotion, stabilizer, chlorines, algaecide, dirt, pollen, etc. Normally this is less of a problem with outdoor pools because of rain water and no use during winter months. Heavily used indoor pools sometimes have a buildup of dissolved solids requiring draining the pool and refilling with fresh water. Most pools should be drained after 3 to 5 years. Ideally pool water contains under 2,000 ppm total dissolved solids.

**DISINFECTION OF POOL WATER**
A proper balance of the previously described water chemistry factors will provide water that will not damage pool components and is non-irritating to swimmers. It is then necessary to provide for disinfection of the water to prevent the spread of disease organisms from person to person and prevent unwanted growth of bacteria and algae in the pool.

**Chlorine**
The most commonly used disinfectant for swimming pools is chlorine. In its elemental form chlorine is a heavy greenish yellow gas which is so toxic that is has been used as a weapon in chemical warfare. Because of the
extremely high potential for injury or death from improper use of chlorine gas, a number of chlorine compounds have been formulated to provide chlorine in forms that can be handled and used safely by swimming pool operators.

The following forms of chlorine are commonly used in swimming pools:

<table>
<thead>
<tr>
<th>Chlorine Form</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Chlorine</strong></td>
<td>100% available chlorine</td>
<td></td>
</tr>
<tr>
<td><strong>Advantages:</strong></td>
<td>Cheapest form of chlorine</td>
<td>Extremely dangerous</td>
</tr>
<tr>
<td></td>
<td>No residue from carriers</td>
<td>Special room needed for chlorine</td>
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<tr>
<td></td>
<td></td>
<td>Feed equipment is expensive</td>
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<tr>
<td></td>
<td></td>
<td>Special training and safety equipment needed</td>
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<tr>
<td></td>
<td></td>
<td>Lowers pH, must constantly add pH increaser</td>
</tr>
<tr>
<td><strong>Disadvantages:</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because of the special hazards associated with the use of gaseous chlorine, its use has been prohibited at public swimming pools in North and South Carolina.</td>
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</tr>
<tr>
<td>Elemental chlorine is a greenish gas at room temperature. Packaged under pressure as a liquid in metal bottles, it is fed into the recirculation system by specially designed equipment. If the chlorine gas escapes from the container or feeder apparatus, it will aggressively attack virtually all surroundings, especially if water or moisture is present. It is also highly toxic to man. Because of the hazardous nature of chlorine gas, its proper handling must be thoroughly understood by those responsible for handling containers and operating feeding devices. Normally, the cost of elemental chlorine is considerably less than the cost of commercial chlorine bearing compounds. It is therefore the most commonly used chlorine sources in the large swimming pools where feed rates and consumption are high. The cost of the extra soda ash required for this type of chlorine must be taken in account in making any cost comparison.</td>
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</table>

| **Calcium Hypochlorite** | Granular or pelletized 65% available chlorine |                                                   |
| **Advantages:**          | Relatively cheap                               | Not stabilized - may lose strength if not tightly covered. |
|                        | Can be mixed into solution for feed pumps      | Does not dissolve completely - leaves residue      |
|                        | Can be used in some specially designed erosion feeders |                                                   |
| **Disadvantages:**       |                                                  |                                                   |
|                        |                                                  | Does not dissolve completely - leaves residue      |
|                        |                                                  | High pH (11.7) raises pH of pool                    |
|                        |                                                  | Highly reactive - may cause fires                   |

**WARNING** - do not use in closed tablet feeders designed to use other forms of chlorine

Calcium hypochlorite is a relatively stable compound of chlorine and calcium, commercially packaged either as granular or in tablet form. It is a safer material than chlorine gas with respect to handling and feeding, but it may present serious problems if spilled or scattered in a moist or wet environment or if oxidizable material is introduced to the container. When applied to swimming pool water calcium hypochlorite reacts much the same as chlorine gas. It tends to release free chlorine from the stabilizing agent and the resulting hydrolysis produces varying chlorine reactions. Due to the relatively compact nature of the package material, calcium hypochlorite is a popular chlorine source in small-/medium-sized swimming pools. Although it is a more costly source than gaseous chlorine (in net yield), this disadvantage is somewhat offset by the relative ease and safety of handling, storage and feeding. The most commonly used calcium hypochlorites will yield 70 percent available chlorine by weight. Calcium hypochlorite can be manually fed directly into the pool from hand-held containers to either facilitate super chlorination or as an alternate feed in the event of equipment failure. Vacuuming of the pool is needed after the chemical is added in this manner. Normally, however, it is mixed with water in tanks or feed crocks and the clear liquid is fed to the recirculation system by mechanical feeders. Such feeders are adjustable to control rates of continuous or intermittent feed.

| **Sodium Hypochlorite** | Liquid bleach 12.5% available chlorine          |                                                   |
| **Advantages:**         | Next to gas is the cheapest chlorine available  | Bulky and heavy                                   |
|                        | No dissolving required - no residue             | Not stabilized-loses strength rapidly             |
|                        | Can be used with chemical feed pumps           | High pH (10-13) raises pH of pool                 |

a. Sodium hypochlorite is a liquid compound of chlorine, water and sodium which is usually packaged in carboys or drums. If properly stored, it will yield 10 percent to 15 percent net chlorine depending upon its method of manufacturer and the age of the material. Like calcium hypochlorite it is relatively safe and easy to handle and
feed, but it is also a hazardous product to spill. Applied to pool water the hydrolysis reactions are essentially like those of other chlorine sources.

b. Mechanical feeding is accomplished in the same manner and by the same type of equipment used to feed the mixture of calcium hypochlorite and water. Sodium hypochlorite need not be premixed with water. It is a feedable liquid in its packaged form when the proper feeder is used.

<table>
<thead>
<tr>
<th>Trichloroiso cyanuric Acid (Trichlor): sticks or tablets 90% available chlorine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages:</strong></td>
</tr>
<tr>
<td>Stabilized - chlorine doesn't dissipate</td>
</tr>
<tr>
<td>Easy to handle</td>
</tr>
<tr>
<td>Low cost, low maintenance erosion feeders</td>
</tr>
<tr>
<td>Highly concentrated - 90% available chlorine</td>
</tr>
<tr>
<td>Dissolves completely - very little residue</td>
</tr>
</tbody>
</table>

Chlorinated cyanurate is available commercially in both white powder and tablet form. The most commonly marketed cyanurates contain from 60 percent (Dichlor) to 90 percent (Trichlor) available chlorine. The physical appearance, handling precautions, and techniques of feeding, etc., of this group of chlorine-bearing compounds are the same as calcium and sodium hypochlorite. The important product differences involve the chemistry of hydrolysis. The cyanurates provide chlorine residual which is relatively more stable and therefore longer lasting in pool water than that provided by elemental and hypochlorite forms. Although such stability reduces disinfection and oxidation properties, it may be desired for other reasons.

<table>
<thead>
<tr>
<th>Salt Chlorine Generators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages:</strong></td>
</tr>
<tr>
<td>Not Stabilized</td>
</tr>
<tr>
<td>Easy to handle – you use SALT</td>
</tr>
<tr>
<td>Low cost over time</td>
</tr>
<tr>
<td>Dissolves completely - very little residue</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Ocean water has a salt content of around 35,000 parts per million ("ppm"). Humans have a salt taste threshold of around 3,500 ppm. Most chlorine generators require a salt content of 2500 - 6000 ppm in the pool. A unit that needs less than 3500 ppm to operate effectively is optimal. A chlorine generator's main function is to produce chlorine for the pool so you do not have to buy it, store it or handle it. These are big advantages for many pool owners. Chlorine generators, when functioning correctly, produce chlorine constantly (when the pump is running) with most units. This keeps a residual of chlorine in the pool that prevents algae from growing. The secret is keeping the cell free of calcium and mineral deposits--the cell itself is made up of precious metals-it must be maintained so it can continue to make chlorine. Through the process of electrolysis, water passing over the chlorine generator cell produces chlorine that is instantaneously transformed into Hypochlorous acid. When any type of chlorine is added to water it ALL makes the SAME thing: Hypochlorous acid. It does not matter if it is Sodium Hypochlorite (liquid chlorine), Tri-chlor and Di-chlor or Lithium based, Cal-hypo or even gas chlorine--it all makes Hypochlorous acid. Hypochlorous acid is the active sanitizer; this is what kills algae and other harmful stuff in the water. Its effectiveness is totally predicated on balanced water conditions and, more importantly, proper pH. So, with a salt water system or chlorine generator, you still must maintain your water balance (pool chemistry) properly. As long as you do this, a chlorine generator is a good choice.

Other forms of chlorine less commonly used are lithium hypochlorite, potassium dichloroisocyanuric acid, and sodium dichloroisocyanuric acid.

Free Chlorine Residual is the amount of chlorine in the pool which has not reacted with substances other than water. It is the chlorine which is available to disinfect pool water and oxidize organic substances. Free chlorine residual should be maintained between 1 and 3 ppm.

Combined Chlorine is chlorine in the pool which has reacted with substance other than water and is no longer available in its free state. Some combined chlorines are bactericides but they contribute little to the disinfection process. Chlorine combined with ammonia produces chloramines which cause eye irritation and an
objectionable chlorine odor. For this reason combined chlorine residual should be kept to a minimum preferably below 0.2 ppm.

Total Chlorine residual is the concentration of free chlorine plus combined chlorine. To determine combined chlorine residual test for free chlorine and total chlorine.

\[ \text{Total chlorine - free chlorine} = \text{combined chlorine} \]

**Breakpoint Chlorination** is the process by which combined chlorine and some organics are “burned out” of the pool by addition of large amounts of chlorine. The reaction of chlorine with ammonia to form chloramines occurs in several stages with free chlorine consumed at each stage. If enough chlorine is added to the water the total chlorine residual will rise to a point that forces the reaction of chlorine with ammonia to go rapidly to completion. Compounds of nitrogen and chlorine are released from the water and the apparent residual chlorine decreases. The point at which the chlorine residual suddenly drops is called the breakpoint. When enough chlorine is added to pass the breakpoint, combined chlorine compounds disappear, eye irritation potential and chlorine odors disappear, and the chlorine remaining in the water is all in the free state.

**Superchlorination:** In order to prevent buildup of chloramines in the pool it is necessary to periodically add large amounts of new chlorine in an effort to pass the breakpoint. Public swimming pools should be superchlorinated when needed which maybe once a week. The amount of chlorine needed to reach the breakpoint will vary depending on the amount of organic material introduced by bathers and on the level of free chlorine maintained in the pool. If the amount of combined chlorine is known then the amount of new chlorine needed is ten times the amount of combined chlorine. When combined chlorine residual is not known, superchlorination is accomplished by adding 10 ppm of new chlorine to the pool. Ordinarily calcium hypochlorite at a dose of at least 1 lb. per 10,000 gallons is used for superchlorination.

**Non-chlorine Shock Treatments** Several products have been developed which oxidize organics without the use of chlorine. Pools which use those products can accomplish the reduction of organics without closing the pool for any longer than it takes to dissolve and distribute the chemicals. Those products are more expensive than chlorine but may be preferred where it is necessary to keep a pool open. How pH affects free chlorine residual Chlorine reacts with water to form Hypochlorous acid (HOCl). The reaction is different for each form of chlorine but hypochlorous acid is produced by each of those reactions and is the form in which chlorine serves best as a disinfectant. Hypochlorous acid is a weak acid and easily dissociates to an ionized hypochlorite state as shown below. This is important because both hypochlorous acid and the hypochlorite ion are counted as free chlorine residual on your test kit but only the hypochlorous acid portion is an effective disinfectant. The balance between hypochlorous acid and the hypochlorite ion is affected by pH. The higher the pH, the less hypochlorous acid present and the less effective free chlorine becomes. At a pH of 7.2 about 66% of free chlorine is hypochlorous acid. At a pH of 7.8 only about 33% of free chlorine is hypochlorous acid. Thus pH control is essential for maintaining the effectiveness of chlorine as a disinfectant.

**Stabilizer - Cyanuric Acid**

Hypochlorous acid is a highly unstable molecule which dissipates rapidly in the presence of sunlight. This results in considerable loss of free chlorine form pools exposed to sunlight. Proper stabilization of chlorine with cyanuric acid slows the rate of chlorine dissipation without appreciably sacrificing oxidation and disinfection activity. Reaction of free chlorine with cyanuric acid produces a form of combined chlorine (chlorimide) which is active enough to aid disinfection and show up as free chlorine residual on your test kit. Proper stabilization requires 30 to 50 ppm cyanuric acid. Outdoor pools should be initially treated with 20 ppm cyanuric acid. Understand that when using Trichlor or Dichlor cyanuric acid will be added along with the chlorine in the product Cyanuric acid dissolves very slowly and is best predissolved in warm water before introducing into the pool. If it is not predissolved it may take several days to dissolve completely. Once added to the pool, cyanuric acid does not dissipate. It is removed from the pool only by splash out and backwash waste. Stabilized chlorine products such as trichloroisocyanuric (Trichlor) acid will add stabilizer to the pool and may cause a gradual rise in cyanuric acid concentration. Excessive amounts of cyanuric acid can interfere with the disinfection process and at concentrations above 100 ppm may cause “chlorine lock” and clouding of the pool. Cyanuric acid level is lowered by draining part of the water out of the pool and diluting the remaining water with fresh water. Generally cyanuric acid level should be kept below 60 ppm. Stabilized forms of chlorine should not be used for superchlorination because cyanuric acid level may be increased.

**Bromine**

Bromine is chemically very similar to chlorine. Bromine compounds tend to react more slowly than chlorine compounds so bromine is generally more stable and less subject dissipation in sunlight. The dissociation of
hypobromous acid into the bromine ion is less affected by pH than the corresponding reaction of chlorine. This makes bromine active over a larger range of pH than chlorine. Bromine will combine with ammonia to form bromamines similar to chlorine but unlike chloramines, bromamines are effective bactericides and do not produce the degree of odor and eye irritation associated with chloramines. Bromine is less affected by high temperature and nitrogen wastes than chlorine so it is particularly attractive for use in hot water spas. Bromine is more expensive than chlorine and has not yet received widespread acceptance by swimming pool operators. The form of bromine most commonly used in pools and spas is the organic chemical bromo-chlorodimethylhydantoin which contains both bromine and chlorine. It is marketed under various trade names and is generally in tablet form for use in erosion feeders.

Bromine residual should be maintained between 2 and 4 ppm. Bromine residual is measured using the DPD #1 test used to measure free chlorine. If your test kit does not include a bromine scale then bromine residual is approximately 2.25 times the reading on the chlorine scale.

**Biganide disinfectants**

The only disinfectant other than chlorine and bromine which has been accepted, only in some states, as a primary disinfectant in public swimming pools is polyhexamethylene biguanide. Biguanide is used at a concentration of 30 to 50 parts per million and a pH of 7.2 to 7.8 to kill germs and control algae growth. A special test kit is needed to test the biguanide residual. The main advantage of biguanide is the disinfectant concentration remains fairly stable so it requires less frequent adjustment than chlorine. No automatic chemical feeder is needed.

Biguanide is not an oxidizer and will not destroy organic wastes the way chlorine and bromine do. It must be used in conjunction with a peroxide shock treatment to prevent organic wastes from accumulating in pool water. Biguanide is incompatible with chlorine and most algicides. Chlorine in make-up water can cause clouding of biguanide pools. Biguanide increases the staining potential of dissolved metals in a pool so copper based algicides, copper ion generators, and pool heaters should not be used. Only chemicals recommended by the disinfectant manufacturers should be used.

**Supplemental disinfection equipment**

A variety of supplemental disinfection process equipment is being marketed for use on swimming pools. The most common are copper/silver ion generators, ozone generators, and ultraviolet light generators. While each process provides some disinfection activity, they are not accepted as primary disinfectants in public swimming pools because they are either too slow or do not provide a disinfectant residual. Supplemental disinfection equipment, if used, must be used in conjunction with a free chlorin or bromine residual.

**Safety Issues**

- Never mix chemicals together unless the instructions say to do so. Always read and reread instructions on any chemical container.
- If any type of mechanical chlorinator is used, use only the chemicals recommended for use in it. A fire or explosion may result if this warning is not heeded.
- Always mix chemicals into water, not water into the chemicals.
- If you use the same bucket to add different chemicals to the pool water be sure it is clean before introducing a new chemical.
- Do Not put wet scoops into dry chemicals.
- It is recommended to have available a full bucket (labeled) of plain water in case of a chemical spill.
- Know what to do in case of an emergency. Always have the poison control center phone number posted and on hand near the pool.
- Do not smoke near any chemicals. Many chemicals give off fumes that could explode. Be careful not to inhale any fumes. It is best to use rubber gloves, protective clothing, and protective eye wear when handling chemicals.
- Read and follow label directions and safety precautions. Review any first aid information on the packaging.
- Have a first aid kit near the pool area, along with some type of rescue tube, reaching pole and/or throwing device (ring buoy) in the pool area. Most state and local codes will inform the pool operator of the proper safety equipment needed. The most recent changes require all lifeguards to be trained with rescue tubes.
SATURATION INDEX

The saturation index uses four factors of the pool water to determine whether it is balanced, corrosive, or scale forming. The factors are pH, water temperature, calcium hardness, and total alkalinity. If the saturation index is on the high side the water can be scale forming in the pipes and mechanical equipment. If the index indicates the water is on the low side the pool water is then likely to be corrosive to any metal parts. If the chemical readings are kept near or at the target settings the water will be in balance. The target range is -.3 to +.3, the negative side means the water is becoming corrosive and the positive side means the water is becoming scale forming.

SATURATION INDEX = (pH + TF + CF + AF) – 12.1 (TDS <1000)

SATURATION INDEX = (pH + TF + CF + AF) -12.2 (TDS 1000 or >)

pH = the pH value as the water is tested

TF = is a calculated factor for the water temperature

CF = is a calculated factor for the water hardness

AF = is a calculated factor for the water’s alkalinity

<table>
<thead>
<tr>
<th>Temperature in Degree F</th>
<th>Temp. Factor TF</th>
<th>Calcium Hardness in PPM</th>
<th>Calcium Factor CF</th>
<th>Total Alkalinity in PPM</th>
<th>Alkalinity Factor AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>0</td>
<td>5</td>
<td>.3</td>
<td>5</td>
<td>.7</td>
</tr>
<tr>
<td>37</td>
<td>.1</td>
<td>25</td>
<td>1</td>
<td>25</td>
<td>1.4</td>
</tr>
<tr>
<td>46</td>
<td>.2</td>
<td>50</td>
<td>1.3</td>
<td>50</td>
<td>1.7</td>
</tr>
<tr>
<td>53</td>
<td>.3</td>
<td>75</td>
<td>1.5</td>
<td>75</td>
<td>1.9</td>
</tr>
<tr>
<td>60</td>
<td>.4</td>
<td>100</td>
<td>1.6</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>66</td>
<td>.5</td>
<td>150</td>
<td>1.8</td>
<td>150</td>
<td>2.2</td>
</tr>
<tr>
<td>76</td>
<td>.6</td>
<td>200</td>
<td>1.9</td>
<td>200</td>
<td>2.3</td>
</tr>
<tr>
<td>84</td>
<td>.7</td>
<td>300</td>
<td>2.1</td>
<td>300</td>
<td>2.5</td>
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<tr>
<td>94</td>
<td>.8</td>
<td>400</td>
<td>2.2</td>
<td>400</td>
<td>2.6</td>
</tr>
<tr>
<td>105</td>
<td>.9</td>
<td>800</td>
<td>2.5</td>
<td>800</td>
<td>2.9</td>
</tr>
<tr>
<td>128</td>
<td>1.0</td>
<td>1000</td>
<td>2.6</td>
<td>1000</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Always Round Up (Example a total alkalinity reading of 30 ppm would be rounded up to 50 ppm)

Worksheet:

(pH________ + TF_________ + CF_________ + AF________) – 12.1 = ________ Saturation Index

(pH________ + TF_________ + CF_________ + AF________) – 12.2 = ________ Saturation Index

(pH________ + TF_________ + CF_________ + AF________) – 12.1 = ________ Saturation Index

(pH________ + TF_________ + CF_________ + AF________) – 12.2 = ________ Saturation Index

<table>
<thead>
<tr>
<th>Pool # 1</th>
<th>Pool # 2</th>
<th>Pool # 3</th>
<th>Spa</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH = 7.5</td>
<td>pH = 7.2</td>
<td>pH = 7.8</td>
<td>pH = 7.5</td>
</tr>
<tr>
<td>Temp. = 85</td>
<td>Temp. = 75</td>
<td>Temp. = 92</td>
<td>Temp. = 104</td>
</tr>
<tr>
<td>Hardness = 200</td>
<td>Hardness = 30</td>
<td>Hardness = 500</td>
<td>Hardness = 100</td>
</tr>
<tr>
<td>Alkalinity = 100</td>
<td>Alkalinity = 60</td>
<td>Alkalinity = 200</td>
<td>Alkalinity = 50</td>
</tr>
<tr>
<td>TDS = 900</td>
<td>TDS = 1500</td>
<td>TDS = 500</td>
<td>TDS = 2000</td>
</tr>
</tbody>
</table>

Saturation Index Scale

> +.3 Scaling potential (Greater than a positive .3 the pool water tends to be scale forming in nature.)

-.3 to +.3 Balanced (From a negative .3 to a positive .3 the pool water is considered balanced.)

< -.3 Corrosive (Less than a negative .3 the pool water is acidic and considered corrosive in nature.)
### Suggested ANSI/NSPI-1; 2003 Appendix A Standards - Swimming Pools

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Ideal</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Chlorine, ppm</td>
<td>1.0</td>
<td>2.0-4.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Combined chlorine, ppm</td>
<td>None</td>
<td>None</td>
<td>0.2</td>
</tr>
<tr>
<td>Bromine, ppm</td>
<td>2.0</td>
<td>4.0-6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>pH</td>
<td>7.2</td>
<td>7.4-7.6</td>
<td>7.8</td>
</tr>
<tr>
<td>Total Alkalinity, ppm</td>
<td>60</td>
<td>80-120</td>
<td>180</td>
</tr>
</tbody>
</table>

Note: (For high pH based chlorines Sodium Hypo, Cal-Hypo and Lithium Hypo the ideal alkalinity is 80-100 ppm)
Note: (For acid based chlorines such as gas chlorine, dichlor, trichlor and bromine compounds the ideal alkalinity is 100-120)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Ideal</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS, ppm</td>
<td>300</td>
<td>1000-2000</td>
<td>3000</td>
</tr>
<tr>
<td>Calcium Hardness, ppm</td>
<td>150</td>
<td>200-400</td>
<td>500-1000+</td>
</tr>
<tr>
<td>Cyanuric Acid, ppm</td>
<td>10</td>
<td>30-50</td>
<td>150</td>
</tr>
</tbody>
</table>

(except where limited by Health Dept. requirements, often to 100 ppm, North Carolina is 100 ppm and South Carolina is 200 ppm)

### Suggested ANSI/NSPI-1; 2003 Appendix A Standards – Spas

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Ideal</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Chlorine, ppm</td>
<td>2.0</td>
<td>3.0-5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Combined chlorine, ppm</td>
<td>None</td>
<td>None</td>
<td>0.5</td>
</tr>
<tr>
<td>Bromine, ppm</td>
<td>2.0</td>
<td>4.0-6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>pH</td>
<td>7.2</td>
<td>7.4-7.6</td>
<td>7.8</td>
</tr>
<tr>
<td>Total Alkalinity, ppm</td>
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<td>80-120</td>
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Note: (For high pH based chlorines Sodium Hypo, Cal-Hypo and Lithium Hypo the ideal alkalinity is 80-100 ppm)
Note: (For acid based chlorines such as gas chlorine, Dichlor, Trichlor and bromine compounds the ideal alkalinity is 100-120)

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>TDS, ppm</td>
<td>300</td>
<td>1000-2000</td>
<td>3000</td>
</tr>
<tr>
<td>Calcium Hardness, ppm</td>
<td>100</td>
<td>150-250</td>
<td>800</td>
</tr>
<tr>
<td>Cyanuric Acid, ppm</td>
<td>10</td>
<td>30-50</td>
<td>150</td>
</tr>
</tbody>
</table>

(except where limited by Health Dept. requirements, often to 100 ppm, North Carolina is 100 ppm and South Carolina is 200 ppm)
Part 6

Water Testing And Adjustments
The Top Ten List for Proper Pool Water Management

1. Know the number of gallons in your pool as accurately as possible (5% +)

2. Know the chemicals you are using in your pool and why. Understand the affect that these chemicals will have on other parameters in your water. (i.e. pH up or down, adding cyanuric acid)

3. Purchase a new complete test kit (once a year) use it, or replace reagents, liquid every 3 months and tablets every year. Follow the manufacturer’s instructions, and repeat any test that does not make sense to see if it correct. Testing of disinfectant and pH levels at least every two hours and spa’s every hour during heavy bather loads.

4. Perform a water test on the make up water so that you know what to expect when adding water.

5. Good record keeping is necessary to function at a high level of efficiency!!!!

6. Have available safety information regarding chemicals, machinery, and other features of the facility. Use and store all chemicals correctly.

7. Keeping the water balanced using the Langelier Saturation Index. Also keep “Free” Chlorine (FC) between 3 and 5 PPM at all times.

8. Do not use or keep at very low levels Cyanuric Acid (CYA/Stabilizer). Try to maintain between 10 PPM and at the most 50 PPM. Outdoor Pools Only.

9. Have a regular cleaning program of brushing and vacuuming of the pool.

10. Keep up with preventative maintenance and making sure equipment is a sized correctly. Check to see that filter media is changed per manufacturer’s instructions.

The Top Two List for Proper Spa Water Management

1. If you have any problem-drain it.
2. Do not let anyone get in it.
3. Disguise as large flowerpot.
4. Really-do everything under Pool Water Management, just more often. The only two things above that I would modify would be keeping your residual for free available chlorine higher and no cyanuric acid at all.

Roy R. Fielding- Sept. 2008
Helpful Hints

1. **Adding Chemicals to your water:** Chemicals should be added slowly over a period of time. Pool owner/operators need to remember that all chemicals added will have an effect beyond their intended purpose. Whether you use the Pool Professor Software or not you need to add chemicals one at a time and normally half the recommended dosage to see if this brings the water into the proper parameters. Retest your water about 2 hours after adding a chemical to see if the other half needs to be added and what other test results may have been affected. It is always easier to add more chemicals to your pool water than it is to take them out if you add too much. You should add chemicals in the following sequence:
   a. Free Chlorine – remember this will affect your pH in some way
   b. Alkalinity – make your life easier and get the alkalinity between 80 and 120 PPM.
   c. pH – from 7.2 and 7.8 so that the other chemicals work properly
   d. Cyanuric acid – understand that this is already contained in Trichlor and Dichlor chlorine products. High levels above 100 PPM may lead to cloudy water and algae growth.
   e. Hardness – 200 to 400 PPM to keep the grout between tiles and the walls of your pool intact.

   Vinyl liner pools do not need the calcium, but the calcium hardness level is still part of properly balanced water.

If your chlorine is in proper adjustment then move to alkalinity, and so forth down the list. Wait and retest after each chemical addition to the pool.

   (note – before the season starts the first thing I would adjust is Total Alkalinity 80 to 120 ppm.)

2. **Volume of water:** Know the number of gallons in your pool as accurately as possible (+ 5%). You need to know the number of gallons to determine how much of what chemical to add to your water. Usually the hardest measurement to determine is your average depth. A pool that was having some problems because the operator was told that the pool was 82 feet by 75 feet with an average depth of 6 feet and had 276,000 gallons. Nothing the pool operator was doing chemically was making sense. Finally, we re-measured the pool by taking one rectangle and making it into four rectangles and had a more precise average depth of 7 feet. This pool had 322,000 gallons not 276,000, a BIG difference.

3. **Understanding the chemicals:** Know the chemicals you are using in your pool and why. Read the label of ingredients to know what you really are buying. Understand the effect that these chemicals will have on other parameters (pH, alkalinity and cyanuric acid primarily) in the water. I use Trichlor sticks, with an erosion feeder, and calcium hypochlorite as his chlorines for my pool.

   The reasons are as follows:
   a. Trichlor lowers the pH and calcium hypochlorite raises the pH.
   b. Trichlor has stabilizer built-in and calcium hypochlorite does not.
   c. Trichlor adds chlorine slowly through an erosion feeder and calcium hypo. can be added quickly.
      (Note: Thoroughly mix the calcium hypo into a 5-gallon bucket of water and lets it settle before adding to the pool. The liquid mixture is poured around the pool perimeter; the white residual is not poured into the pool or skimmer.) Note: Make sure all calcium hypochlorite granules are dissolved before pouring in a vinyl liner pool. More about this in hint Number 4.
   d. Both Trichlor and calcium hypochlorite have a long shelve-life

4. **Using chemicals properly:** The Pool Professor thoroughly mixes the calcium hypo into a five-gallon bucket of water and lets it settle before adding to the pool. I always put the lid on the bucket and let it settle for at least 2 hours before using. Normally I add the mixture at the end of the day so I can start the next morning with a 3 to 5 PPM reading of free chlorine. This technique of using both Trichlor and calcium hypochlorite on a daily basis has reduced my need for soda ash to increase my pH and reduced the amount of cyanuric acid entering my pool by using less Trichlor. Remember – do not mix any chemicals directly together unless instructed to do so. The Trichlor tablets are placed in an erosion feeder and then the chlorine is injected into the return line, this is the correct way to introduce the chlorine into the water. **Note: Make sure to use the chemical recommended by the manufacturer in this type of feeder.** Trichlor sticks, pucks, tablets have a pH of 2.8 which is very acidic, I do not believe in putting most chemicals in the skimmers because of the corrosive affects on metal parts of the filter and heating systems. The calcium hypochlorite solution is poured around the

5. **Make up water:** Perform a complete water test on the water you use to fill the pool so that you know what to expect when adding water. The water you fill your pool with may have a high or low pH, alkalinity, and/or hardness level. I have seen city water supplies with a free chlorine reading of 1.0 PPM, pH of 7.5, and an
alkalinity and hardness of 100 PPM. I have also seen some water supplies with a chlorine reading of 0 PPM and pH 8.4, alkalinity and hardness of 20 PPM. Each water supply and pool will be different.

6. **Record Keeping:** Good record keeping is necessary to function at a high level of efficiency! The more information you track on your pool the more of an understanding you will have in taking care of it.

7. **Safety Information:** Have available safety information regarding chemicals, machinery, and other features of the facility. Use and store all chemicals correctly. Be sure to wear protective eye protection, gloves, and other clothing when working with the chemicals. The less you know about the chemicals used the more dangerous they can be to you.

8. **Proper Pool Water Balance:** Keep the water balanced using either the Langelier Saturation Index. I personally feel that so long as you balance the pool water using the Langelier Saturation Index the equipment and individuals using the pool will be better off. Remember this has nothing to do with chlorine or bromine, but everything to do with pH, total alkalinity, water hardness and the water temperature.

9. **Stabilizer:** Try to maintain the cyanuric acid/stabilizer between 10 PPM and at the most 50 PPM. Remember that Trichlor and DiChlor chlorine add Cyanuric Acid when you add these products to your water.

10. **Cleaning:** Have a regular cleaning program of brushing and vacuuming of the pool. Once a week you brush all of the pool that you can, including the walls, bottom, and inside of the skimmers and gutters. Try to do this at the end of the day and then let everything settle to the bottom overnight. The next morning, before anyone gets in, vacuum the pool thoroughly.

11. **Maintenance:** Keep up with preventative maintenance and making sure equipment is sized correctly. Check to see that filter media is changed per manufacturer’s instructions. Sand in a sand filter should not go bad and have to be replaced on a regular basis. Sand can become contaminated if chemicals are added to the water incorrectly and/or bathers that are using suntan lotion are not taking showers before entering the pool. I have two filters that have had the same sand for over twenty years and are doing an excellent job of filtration.

12. **Test kits:** Purchase a new complete test kit once a year, or replace reagents, liquid every 3 months and tablets every year. Follow the manufacturer’s instructions, and repeat any test that does not make sense to see if it correct. Testing of disinfectant (chlorine) and pH levels at least every two hours and in a spa every hour during heavy bather loads is important to maintain a safer pool environment. I am not yet a fan of test strips, even if I had test strips I would still have a standard test kit on a regular basis to confirm readings. A standard test kit will test free and total chlorine, pH, alkalinity, hardness, and if needed cyanuric acid. I have had a number of people who have told me that they are using test strips and gotten a free chlorine test reading greater than their total chlorine reading – that is mathematically impossible.

13. **Recommendations:**
   a. It is recommended that you do not adjust the water’s alkalinity and hardness within 24 hours of each other. If sodium bicarbonate is used to adjust the total alkalinity you should wait at least 24 hours before adding calcium chloride for increasing water hardness.
   b. Do not increase the Total Alkalinity by more than 50 PPM in a twenty-four hour period time.
   c. Do not lower the Total Alkalinity more than 10 PPM per day.
   d. Do not raise Calcium Hardness more 50 PPM every 8 hours.
   e. Do not lower or raise the pH by more than .2 units on the pH scale at a time. Being that the pH scale is logarithmic this would mean you are attempting to make your water 2 times more acidic or basic than it is presently. Be patient and move it gradually – make sure the alkalinity is in the proper range before moving your pH.

   **BE SURE TO READ THE INSTRUCTIONS CAREFULLY FOR ANY CHEMICAL USED.**
Water Testing Procedures

1. Always start each season or every year with a new complete water testing kit. You need to have a test kit that will test for free chlorine, combined or total chlorine, pH, total alkalinity, calcium hardness, and cyanuric acid.

2. Follow the instructions in the test kit precisely. If the readings do not seem correct, do not hesitate to repeat the test.

3. Make sure your hands are clean before doing the testing, so not to contaminate the test sample. Do not touch the inside or top of the vial or its cap. Do not directly touch any testing reagents.

4. Choose a testing location away from an inlet that returns water from the filter to the pool.

5. Rinse the vial thoroughly with pool water.

6. To fill vial, turn upside-down and submerge the vial 12"-18" below the surface water level. Turn the vial right side up and allow it to fill. Remove the vial carefully.

7. Remove water to the appropriate fill line by gently shaking the vial. If you shake out too much water, start over at Step 3.

8. Complete the appropriate test by following directions carefully inside the test kit.

9. Read the results by holding a white card behind the vial and position yourself so the sun is behind you. Some test kits recommend that you face to the North to cut the glare.

10. Record the results in the appropriate manner.

11. Rinse the vial thoroughly and dry with a paper towel. Any reagent that remains inside the vial may stain the plastic and give false future readings. Store the testing kit in a cool, clean, and dry environment.

NOTE: If the DPD Free Chlorine test turns clear immediately after inserting the tablet or drops, it is likely that the Chlorine levels are high. To confirm, the DPD test for Total Chlorine will turn the sample brown if the chlorine levels are high. A low Chlorine reading will show no color during the entire DPD Free Chlorine or Total Chlorine tests.

Common Pool Problems

Green Algae

Algae are the lowest forms of plant life. Many forms of algae have remained unchanged for billions of years. Green Algae is very fast-growing strain which will spread quickly if you maintain a low chlorine or bromine residual.

Treatment
To get rid of green algae, use the following procedure:
1. Clean (backwash) the pool filter.
2. Brush the algae off the pool walls and pool bottom.
3. Add a non-foaming algaecide.
4. Shock the pool with granular chlorine or liquid chlorine.
5. Add more chlorine as needed to maintain a 3.0 ppm reading.
6. Operate the filtering equipment continuously until the water is blue.
7. Clean the filter as often as necessary during the algae cleanup.

Prevention
Maintain a CONSISTANT sanitizer residual. Above 1.5 ppm if using chlorine and 3 ppm for bromine. Regularly brush your pool walls and bottom.
Vacuum pool on a regular basis.
Do not allow your cyanuric acid reading get to high. (over 50 ppm)

**Mustard (Yellow) Algae**

Another hardy strain that you do not want to get started in your pool or spa. Not as bad as Black Algae, although this form appears to be resistant to normal disinfectants and most algacides. A wall clinging variety, also called yellow algae, is usually found on the shady side of the pool. It is sheet forming, and can be difficult to eradicate completely. Once begun, a pool owner could spend the entire season fighting mustard algae; return of the algae is common.

**Treatment**
1. Backwash filter
2. Brush the algae off the pool walls.
3. Treat the pool with a product specific for the treatment of mustard and yellow algae. It is very important to closely follow the manufacturer's instructions accurately.
4. Add more chlorine as needed to maintain a 3.0 ppm chlorine residual.
5. Wait 24 hours, then brush and vacuum the pool.
6. Backwash filter

**Prevention**
Maintain a CONSISTANT sanitizer residual. Above 1.5 ppm if using chlorine and 3 ppm for bromine. Regularly brush your pool walls and bottom.
Vacuum pool on a regular basis.
Do not allow your cyanuric acid reading get to high. (over 50 ppm)

**Black Algae**
1. Backwash filter.
2. Scrub the algae using a stainless steel algae brush. (This procedure will not remove the algae but will wound or score the algae which will allow the algacide to work.) Nylon brush should be used for vinyl liner pools.
3. Treat the pool with a product made specifically for the removal of Black Algae carefully following the manufacturer's instructions.
4. Wait 24 hours then brush off the dead algae.
5. Backwash filter.

**Prevention**
Maintain a CONSISTANT sanitizer residual. Above 1.5 ppm if using chlorine and 3 ppm for bromine.
Maintain a pH of 7.2 - 7.6
Regularly brush your pool walls and bottom.
Vacuum pool on a regular basis.
Do not allow your cyanuric acid reading get to high. (over 50 ppm)

**Cloudy Water**

Cloudy water is usually caused from either inadequate filtration or inadequate sanitation. Possible causes are listed below:
1. Water is not circulating correctly.
2. Chemical imbalance.
3. Absence of oxidizer (chlorine)
4. If you are using D.E. there may be rip in one of the filter elements.
5. High bather load.
6. Combined Chlorine level above .2 ppm.
7. Inadequate maintenance procedure, brushing and vacuuming, for cleaning.
8. Algae.

**Treatment and Prevention**
1. Make sure circulation system is operating correctly and that the proper number of turnovers are taking place. Use the turnover rate calculator built into the Pool Professor Software. Make sure filters are backwashed properly, and the system is rinsed before returning to normal flow. The hair and lint basket is clean.
3. Make sure to maintain proper chlorine or bromine levels in your water.
5. Always take into account higher than normal bather loads require performing normal procedures more often.
6. Do not let algae get started in your water. 

**Eye and Skin Irritation/Chlorine Odor**

It is a common misconception that red eyes and a strong chlorine smell to the water is the result of too much chlorine. Actually, the cause is not enough chlorine! The combined chlorine compound, called a chloramine, is produced when a free chlorine molecule combines with a nitrogen or ammonia molecule. These compounds smell bad, irritate the eyes and skin, and get in the way of free chlorine trying to do its job. Sometimes the problem is related to lack of proper air circulation in the pool area. This issue should be resolved first before attempting the chemistry fix.

**Treatment**

Check the pH

This could well be a pH problem - the water could be too acidic or too alkaline. The pH of the human eye is around 7.4-7.5 - pool water higher or lower will irritate eyes. Adjust your pH to between 7.2 and 7.6.

Check to see if you have Combined Chlorines:

High combined chlorine (Chloramines) are known to be an irritant. Note carefully the results you get on your DPD #3 test. Eliminate the chloramines down by superchlorinating the pool.

Be careful using some cleaning products:

Some detergents used for cleaning the tile line are incompatible with chlorine. This can unfortunately include many products sold specifically for this application. The resulting reactions in the water can lead to eye and skin irritation. Similar reactions can occur if soaps or shampoos get into the water. Change to cleaners that are chlorine compatible.

**Prevention**

Adequate testing of the water and proper chemical adjustments.

**Colored Water**

1. Green--Generally indicates algae bloom. Treat with non-foaming algaecide and shock
2. Reddish Brown--High iron content. Treat with chelating agent.
3. Blue Green--Usually high copper content caused by over usage of copper-based algaecides. Treat with chelating agent

**Air Bubbles**

1. Check the suction side of the pump.
   A. Low water level in the pool
   B. Ruptured hair trap lid or gasket
   C. Clogged impeller
   D. Damaged feeder line
2. Pressure Side
   A. Clogged impeller

**Pool Problems from your pH**

<table>
<thead>
<tr>
<th>Low pH</th>
<th>High pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitting concrete</td>
<td>Plugged filters</td>
</tr>
<tr>
<td>Dissolve metals</td>
<td>Reduced circulation</td>
</tr>
<tr>
<td>Staining of pool walls</td>
<td>Cloudy pool water</td>
</tr>
<tr>
<td>Chlorine loss increased</td>
<td>Inefficiency of chlorine</td>
</tr>
<tr>
<td>Wrinkles vinyl liners</td>
<td>Causes skin and eye irritation</td>
</tr>
<tr>
<td>Causes skin and eye irritation</td>
<td></td>
</tr>
</tbody>
</table>

Keep pH between 7.2 and 7.8
**Pool Problems with Total Alkalinity**

<table>
<thead>
<tr>
<th>Low Total Alkalinity</th>
<th>High Total Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitting concrete</td>
<td>Plugged filters</td>
</tr>
<tr>
<td>Dissolve metals</td>
<td>Reduced circulation</td>
</tr>
<tr>
<td>Staining of pool walls</td>
<td>Cloudy pool water</td>
</tr>
<tr>
<td>pH bounce</td>
<td>pH upward drift</td>
</tr>
</tbody>
</table>

Keep Total Alkalinity between 80 and 120 ppm

**Pool Problems with Calcium Hardness**

<table>
<thead>
<tr>
<th>Low Calcium Hardness</th>
<th>High Calcium Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etching Plaster</td>
<td>Plugged filters</td>
</tr>
<tr>
<td>Dissolve grout</td>
<td>Reduced circulation</td>
</tr>
<tr>
<td>Pitting of concrete</td>
<td>Cloudy pool water</td>
</tr>
<tr>
<td>Pitting of pool decks</td>
<td>Inefficiency of heater</td>
</tr>
</tbody>
</table>

Keep Calcium Hardness between 200 and 400 ppm
If using Ryznar Index you can increase CH level to 800 ppm

**Pool Problems with Water Temperature**

<table>
<thead>
<tr>
<th>Low Water Temperature</th>
<th>High Water Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water tends to be more corrosive</td>
<td>More scale forming</td>
</tr>
<tr>
<td>Uncomfortable to dangerous</td>
<td>Uncomfortable to dangerous</td>
</tr>
</tbody>
</table>

Keep Pool water temperatures between 78 to 86 degrees
Keep Spa water temperature no higher than 104 degrees

**Problems with High Cyanuric Acid/Stabilizer**

Decreased efficiency of chlorine
- Cloudy water
- Algae formation
- Causes need for more chlorine
  Make sure the chlorine you are using does keep adding CYA

Decreased value for Total Alkalinity

Only way to reduce high levels is drain and refill water

**GENERAL MAINTENANCE**

Because pool equipment and its related piping and instrumentation vary from one pool facility to another, the operating, maintenance, and servicing, instructions provided in equipment manufacturer's literature should be used to augment the instructions provided herein. The different types of equipment and conditions under which they operate make proper lubrication extremely important. Improper lubrication (over lubrication as well as under lubrication) causes damage to wearing surfaces, increases maintenance costs, increases power consumption, and increases power outages.
PREVENTIVE MAINTENANCE
A preventive maintenance program, effectively implemented, will improve equipment operating performance and extend equipment life. In addition, preventive maintenance program records can be used as an inventory planning tool and as a manpower scheduling tool.

ESTABLISHING A PREVENTIVE MAINTENANCE PROGRAM
Establishing a preventive maintenance program requires a record of past operating experience and the equipment manufacturer’s recommendations in order to develop individual equipment maintenance and scheduling requirements).

SEASONAL CARE
Pools that are closed during winter should be inspected once a month during the off-season. Particular attention should be given to any moisture forming in the filter room or chemical storage area. If excess moisture is prevalent, diatomaceous earth filter elements should be removed and stored in a dry place to avoid corrosion. Chemicals stored during the off season should be kept dry to prevent caking or corrosion. The off-season is considered a good time to paint interiors and to repair deck furniture, bathhouse facilities, and electrical fixtures and wiring.

POOL OPENING
Before a pool is opened in the late spring or early summer, certain operation and maintenance routines must be followed. Several months prior to opening, a thorough inspection should be made of all equipment and supplies, including pool shell, deck area, pool inlets and outlets, control valves, drains, heaters, filters, pumps, chemical feed equipment, and electrical systems. Cracking or spalling concrete should be patched with special hydraulic cement or other approved compounds. If necessary, surfaces should be repainted using procedures recommended by the paint manufacturer. The amount and condition of filter media should be checked and replaced as necessary. Adequate chemical supplies should be ordered.

POOL STARTUP
Pool startup includes the following procedures:

a. Chlorinator. The chlorinator should be checked in accordance with the manufacturer’s recommendations. If chlorine bottles have been left connected since the last swimming season, they should be disconnected carefully by someone wearing an air pack or chlorine mask.

b. Soda Ash Feeder. This should be checked to see that it is working properly and that no dried soda ash is remaining inside.

c. Piping and Pumps. Check for proper pump operation and any deteriorated pipe. Where steel pipe has corroded, recommend replacement with PVC pipe.

d. Filters. Where diatomaceous earth filters are used the filter should be disassembled and its elements checked for leaks annually. If socks are used over the filter elements, they should be examined and replaced if holes or worn places are found. If the filter needs extensive repairs, it should be replaced with a high rate sand filter.

e. Sand Filters. Sand filters seldom need maintenance other than backwashing. Check to see that the pressure drop across the filter is not above the manufacturer’s recommendation.

f. Paint. Where the-walls of the pool require painting, use chlorinated rubber base paint. Do not use epoxy since it tends to chalk when exposed to sunlight (even under water) and tends to give the water a milky appearance.

g. Recirculating Lines. When recirculating lines have to be replaced use polyvinyl chloride (PVC) piping. It is not necessary to tear up the deck since the replacement pipe can be grouted into the right angle spaces between the pool sides and the bottom.

h. Remove Floating Debris. Remove leaves and other floating debris from pool surfaces with a leaf skimmer.

i. Add water. If water is added to the makeup tank, the pump is started and the filters are placed in operation when the makeup tank is nearly filled. If water is added directly to the pool, allow the pool to fill approximately one-third full and then turn on the pump and filters. If the only return to the filters is from overflow of the pool, the pool must be filled and overflowed before water is available to the pump and filters, which should then be started. When sand and anthracite filters are first started, add floc and waste the filter effluent for a few minutes until effluent is clear.

k. Chemical Feed. Start chlorination as soon as filtration begins. Start pH control as soon as pH tests of the water indicate need. Take frequent pH and residual chlorine readings.

l. Reduce Water Supply. When the pool is filled, reduce the amount of makeup water from the water supply to the amount that will produce a constant overflow about 1/8 inch deep all around pool overflow troughs or deck level.
Final Check. When pool is ready for use, check turbidity, pH, temperature, alkalinity, hardness, stabilizer (if used) and chlorine residual. Do not open pool until all readings are satisfactory.

POOL CLOSING.
The following procedures should be followed when closing outdoor pools at the end of the season.

a. Wash filters (backwash) several times thoroughly, perform any necessary filter cleaning with appropriate chemicals, and rinse with freshwater. Pump freshwater through all chemical feedlines and equipment. Carefully check operation of all equipment, including pump and motor.

b. Open main pool, filter, and other drains to dewater pool and equipment. Make sure there is a valve at the lowest point in piping system so that all water can be drained. Leave this valve and pool drain valves open to allow rain and snowmelt to runoff. In pools where it is necessary to maintain water to prevent the pool shell from cracking or floating out of the ground, close the main pool drains to maintain desired water level in pool. Drain the filters and all the piping system. Check the main drain valves to be sure there is no leakage.

c. Inspection. Make complete inspection of all equipment and supplies.

d. In order to prevent deterioration of equipment during storage, take the following steps:

1. Open diatomaceous earth filters and check filter elements for cleanliness. If any dirt or grease remains on the elements, use a cleaner recommended by the filter manufacturer or higher technical authority. Handle elements carefully to prevent damage. After cleaning, reassemble and wash the filter several times.

2. Drain all pipelines, pump cases, and the hair catcher. Clean the hair catcher buckets and store them in a dry place.

3. Clean and recondition all check valves, sump pumps, sight glasses, gages, and meters.

4. Thoroughly wash all pump bearings and pump motors with an approved solvent such as kerosene or other armed services approved solvents. Immediately fill bearings with an approved rust preventive compound.

5. Clean all oxidation from exposed copper surfaces on transfer switches, safety switches, pump starters, and other electrical equipment by burnishing the copper with a burnishing tool.

6. In cold climates, remove and empty all traps in lavatories in the bathhouse.

7. If the pool is to be left full of water, logs or other materials approved by higher technical authority should be floated to prevent ice damage. Material should be fastened to maintain spacing and prevent bunching. Plastic covers should be securely fastened to prevent algae growth and keep out debris.

8. Remove ladders and clean them with a chrome cleaner or polish. Put one ladder back in place in the pool; store the remaining ladders in a safe place.

9. Remove ladders and clean them with a chrome cleaner or polish. Put one ladder in place in the pool; store the remaining ladders in a safe place.
### Chart for Chemical dosages required to affect 10,000 gallons of water by 1 part per million (ppm)

<table>
<thead>
<tr>
<th>Increase Free Chlorine</th>
<th>1 ppm</th>
<th>Increase Total Alkalinity</th>
<th>1 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine Gas</td>
<td>1.3 oz.</td>
<td>Sodium Bicarbonate</td>
<td>2.24 oz.</td>
</tr>
<tr>
<td>Trichlor</td>
<td>1.5 oz.</td>
<td>Sodium Carbonate</td>
<td>1.4 oz.</td>
</tr>
<tr>
<td>Dichlor</td>
<td>2.5 oz.</td>
<td>Sodium Sesquicarbonate</td>
<td>2.0 oz.</td>
</tr>
<tr>
<td>Calcium Hypochlorite</td>
<td>2 oz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium Hypochlorite</td>
<td>3.8 oz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>10.7 fl. oz.*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decrease Total Alkalinity</th>
<th>1 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Bisulfate</td>
<td>3.36 oz.</td>
</tr>
</tbody>
</table>

(For best results use the “pour in a column” technique for adding these chemicals. It will have less effect of pH)

<table>
<thead>
<tr>
<th>Decrease Free Chlorine</th>
<th>1 ppm</th>
<th>Increase Calcium Hardness</th>
<th>1 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Thiosulfate (2.6 oz. NSPF)</td>
<td>1.4 oz.</td>
<td>Calcium Chloride (100%)</td>
<td>1.44 oz.</td>
</tr>
<tr>
<td>Sodium Sulfite</td>
<td>2.4 oz.</td>
<td>Calcium Chloride (77%)</td>
<td>1.92 oz.</td>
</tr>
<tr>
<td>Hydrogen Peroxide (35%)</td>
<td>2.6 fl. oz.*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Increase Stabilizer</th>
<th>1 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanuric Acid</td>
<td>1.3 oz.</td>
</tr>
<tr>
<td>Dichlor</td>
<td>2.5 oz.</td>
</tr>
</tbody>
</table>

**Pool/Spa Water Adjustment Formula (except for pH)**

\[
\text{Amount of Chemical (from chart above)} \times \frac{\text{Amount of Change in PPM}}{10,000} = \text{Total Amount Needed to make desired change}
\]

For pounds divide oz. by 16
For gallons divide fl. oz. by 128*
Chart for Chemical dosages required to affect 10,000 gallons of water by .2 on the pH Scale

<table>
<thead>
<tr>
<th>Increase pH</th>
<th>0.2</th>
<th>Decrease pH</th>
<th>0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda Ash</td>
<td>10.4 oz.</td>
<td>Muriatic Acid</td>
<td>13.3 fl. oz.*</td>
</tr>
<tr>
<td>Caustic Soda</td>
<td>5.55 fl. oz. *</td>
<td>Sodium Bisulfate</td>
<td>20.8 oz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sulfuric Acid</td>
<td>11.2 fl. oz*</td>
</tr>
</tbody>
</table>

For best results use the “dilution” technique for adding these chemicals to your water. It will have less effect on alkalinity.

### Pool/Spa Water pH Adjustment Formula

<table>
<thead>
<tr>
<th>Amount of Pool Volume by 10,000</th>
<th>Chemical (from chart above)</th>
<th>Total Amount Needed to make a .2 change in pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{\text{chemical amount}}{10,000}$</td>
<td>$\frac{\text{chemical amount}}{10,000}$</td>
<td>$\frac{\text{chemical amount}}{10,000}$</td>
</tr>
</tbody>
</table>

For lbs. divide oz. by 16
*For gals. divide fl. oz. by 128

It is best to change pH at a rate of .2 at a time.

### Pool/Spa Water pH Adjustment Example

You have a 250,000 gallon pool. The pH reading for the pool is 7.8 and you want to lower it to 7.6 using Muriatic acid.

Divide the
Pool Volume
by 10,000

Amount of Chemical
(from chart)

___25___ $\times$ __13.3___ $=$ ___332.5 fluid ounces or 2.6 gallons___

Total Amount Needed to make a .2 change in pH

For lbs. divide oz. by 16
*For gals. divide fl. oz. by 128

It is best to change pH at a rate of .2 at a time.

### Pool/Spa Water pH Adjustment Example

You have a 150,000 gallon pool. The pH reading for the pool is 7.2 and you want to raise it to 7.4 using soda ash.

Divide the
Pool Volume
by 10,000

Amount of Chemical
(from chart)

___15___ $\times$ __10.4___ $=$ ___156 ounces or 9.75 pounds___

Total Amount Needed to make a .2 change in pH

For lbs. divide oz. by 16
*For gals. divide fl. oz. by 128

It is best to change pH at a rate of .2 at a time.
**Breakpoint Chlorination/SuperChlorination Calculations**

**Step 1.** Do a complete water test for Total Chlorine (TC) and Free Chlorine (FC). When you use the following formula \[ TC - FC = CC \] the result will be Combined Chlorine (CC).

**Step 2.** Use the formulas below to determine how much, of the chlorine of choice, you need to reach breakpoint.

<table>
<thead>
<tr>
<th>Divide Pool Volume by 10,000</th>
<th>When using</th>
<th>Combined Chlorine Value (CC)</th>
<th>Amount needed to reach Breakpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \frac{500,000}{10,000} ] ( \times ) [13] ( \times ) [ \text{X} ]</td>
<td>Calcium Hypochlorite</td>
<td></td>
<td>Total in ounces (Divide by 16 for lbs)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Divide Pool Volume by 10,000</th>
<th>When using</th>
<th>Combined Chlorine Value (CC)</th>
<th>Amount needed to reach Breakpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \frac{500,000}{10,000} ] ( \times ) [38] ( \times ) [ \text{X} ]</td>
<td>Lithium Hypochlorite</td>
<td></td>
<td>Total in ounces (Divide by 16 for lbs)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Divide Pool Volume by 10,000</th>
<th>When using</th>
<th>Combined Chlorine Value (CC)</th>
<th>Amount needed to reach Breakpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \frac{500,000}{10,000} ] ( \times ) [107] ( \times ) [ \text{X} ]</td>
<td>Sodium Hypochlorite</td>
<td></td>
<td>Total in fluid ounces (Divide by 128 for gallons)</td>
</tr>
</tbody>
</table>

**Example**

You have a 500,000 gallon pool. When you test the water your Free Chlorine (FC) is 1.0 ppm and the Total Chlorine (TC) is 1.5 ppm. Your job is to determine of much chemical is needed to reach breakpoint chlorination.

<table>
<thead>
<tr>
<th>Divide Pool Volume by 10,000</th>
<th>When using</th>
<th>Combined Chlorine Value (CC)</th>
<th>Amount needed to reach Breakpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \frac{500,000}{10,000} ] ( \times ) [20] ( \times ) [0.5] =</td>
<td>Calcium Hypochlorite</td>
<td></td>
<td>500 ounces</td>
</tr>
</tbody>
</table>

Divide 500 ounces by 16 to determine number of pounds. To superchlorinate this pool in order to reach breakpoint you need to add at least 32 pounds.
Part 7

Other
Glossary of Terms

Acid  A chemical which lowers the pH and total alkalinity when added to the pool's water, should be handled with care. Read directions completely.

Algae  Microscopic form of aquatic plant life. They are introduced into the pool by wind and rain and can quickly grow colonies. Green, yellow and black are the most common forms. The so-called "pink" algae is actually a bacteria.

Algaecides  A product designed to prevent and control algae growth. This product is normally not needed if you have been chemically treating the pool correctly. Once algae gets a foot hold, it is tough to get rid of.

Backwash  The process of cleaning a pool filter is usually done by reversing the water flow through the filter.

Balanced Water  The minerals, calcium hardness, and total alkalinity, pH and temperature of the pool water are in the correct ratio. If the water is not balanced, the water could be either scale forming or corrosive in nature. The Pool Professor 2000 makes it easy to see whether the water is balanced or not, and how to correct it if necessary.

Bromine  Bromine is a popular disinfectant for spas and can be used in some pool situations. Bromine is not affected as greatly as chlorine is at elevated water temperatures, such as in a spa. Bromine remains more effective in a wider range of pH values than chlorines do.

Calcium Hardness  This is the amount of calcium that is dissolved into the pool water. The level of calcium hardness will tell if you have "hard" or "soft" water. If there is a low calcium level, the pool water will precipitate calcium from the concrete surfaces. With an high level of calcium, the water may be cloudy and scale forming.

Calcium Hypochlorite  A type of chlorine that comes in granular or tablet form. It has about 65% available chlorine, and about 35% filler. This chemical must be handled with care.

Chlorine (pure)  A highly poisonous gas that is compressed into liquid form. It is mainly for use at water treatment plants and commercial pools. It must be handled with extreme caution.

Chlorine Demand  The amount of chlorine necessary to burn away (oxidize) the unwanted organics in the pool.

Chlorine Residual  The chlorine level that is left in the pool after the oxidation process is completed. Also referred to as Free Chlorine (FC)

Combined Chlorine  When the chlorine is in a combined state, it is very ineffective.

Corrosion  Caused by unbalanced and aggressive water on the metal parts of the pool. Metal parts are eaten away by low pH, low calcium hardness, or low total alkalinity.

Cyanuric Acid  A chemical known also as a stabilizer, conditioner or CYA. It helps stop sunlight from dissipating of chlorine. This chemical never leaves the pool, except when you backwash or by water being splashed out of the pool. CYA levels of 10 to 50 ppm should work well in most outdoor pool, THIS SHOULD NEVER BE USED WITH AN INDOOR POOL OR SPA.

Free Chlorine  The portion of the Total Chlorine which is not combined with organics and is available to kill bacteria.

Hardness (water)  Refers to the amount of dissolved minerals in the pool water, mainly calcium. A high level may cause scaling to form in the pipes, filter and heater. A low hardness level may cause the dissolving of grout, pitting of concrete, and etching of plaster.
**Hypochlorite**  A compound formed when a metal combines with chlorine. It is commonly sold as Calcium, Sodium, or Lithium Hypochlorite for use in swimming pools.

**Liquid Acid (Muriatic)** Used to reduce pH and total alkalinity in pools. It is a very strong acid and must be handled and stored with extreme care.

**Organic Matter** Perspiration, urine, saliva, suntan oils, pollen, leaves, insects, etc.... Organics increase chlorine demand significantly and should be removed at once, either by vacuuming or super chlorination.

**MSDS** Material Safety Data Sheets are required by law to have at the work place for all chemicals used. A Hazard Communication Program in writing is required by law.

**pH** A scale that indicates if the pool water is basic, acidic, or neutral. The most accepted reading for the swimming pool water is slightly basic, 7.2 to 7.6. If the pool water has a pH of 7.8 and above it may cause cloudiness and scale formation. If the pool water is below 7.0 it is becoming too acidic and can become corrosive in nature. The range of 7.2 to 7.6 is the best range for swimmer comfort and for effectiveness of the chlorine levels. pH is measured on a logarithmic scale, which means if the pool water goes from a pH of 8.0 to 7.0 the water has become 10 times more acidic. Likewise if the pH would go from 8.0 to 5.0 the water would be 1000 times more acidic.

**ppm** A unit of measure. 1 part of 1 million parts.

**Saturation Index** Predicts if the pool water is corrosive, scale forming, or balanced, by using the relationship between temperature, calcium hardness, total alkalinity, and pH. This is the best test so far for total pool water control.

**Scale** Usually caused by high levels of mineral content (calcium) and pH. Form in the heater, pool walls, and filter. Scaling can significantly shorten the life of the heater and filter.

**Soda Ash** Used to raise pH and total alkalinity in the pool water. Also sold as Sodium Carbonate.

**Sodium Bicarbonate** Commonly referred to as baking soda. This is the chemical of choice when wanting to raise the total alkalinity, because it has little effect on the pH.

**Sodium Bisulfate** A dry form of acid. When mixed with water and added to the pool water, it lowers the pH and total alkalinity. It is safer to store and handle than muriatic acid, but care must be taken.

**Sodium Hypochlorite** A stronger version of household bleach. One of the most common forms of chlorines used.

**Sodium Thiosulfate** This chemical is used when the chlorine level becomes too high in the pool. It is a dechlorinator (kind of like a terminator of chlorine).

**Stabilizer** (See cyanuric acid)

**Superchlorination** (Shocking) A process of adding a greater than normal amount of chlorine to pool water. This is done to “burn out” a large amount of organic matter in the pool that has caused the normal amount of chlorine to be ineffective. The Pool Professor Software indicates the proper amount of chlorine needed to achieve proper superchlorination.

**Total Alkalinity** Testing for Total Alkalinity is very important as the Total Alkalinity helps maintain the pH in the proper range. If the total alkalinity is too high, it is hard to adjust the pH. If the total alkalinity is too low, it is hard to maintain the proper pH range, because it becomes unstable. (Too few pool owners do this test.)
Websites of Interest

State Codes –
North Carolina  http://www.deh.enr.state.nc.us/ehs/quality/poolinks.htm
South Carolina  http://www.scdhec.net/eqc/water/html/recreation.html

Center for Disease Control  http://www.cdc.gov/healthyswimming/poolstaff.htm

The Pool Professor  http://www.thepoolprofessor.com  Email – support@thepoolprofessor.com

filters  http://www.poolcenter.com/filter.htm

http://waterandhealth.org/tips/poolchemicals.html

All round  http://waterandhealth.org/pool_spa/
http://www.cdc.gov/healthyswimming
http://www.poolcarevideo.com/pools/index.html?catalog0_0.html

Professional Organization  http://www.ppoa.org
Name of Pool: _______________________________ Address _______________________

Monthly Record - Month: ____________ YR ___ Pool Type: _______________

Last Name of Pool Operator(s):

<table>
<thead>
<tr>
<th>Date-Time</th>
<th>CL-BR</th>
<th>PH</th>
<th>Pool Drain Inspection</th>
<th>Total alkalinity</th>
<th>Temp</th>
<th>Cyanuric Acid</th>
<th>Maintenance activities</th>
<th>Initials</th>
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*Record total alkalinity and cyanuric acid weekly. The pool operator shall inspect the pool daily and maintain written records.*
Mandatory Report of Illness, Injury, or Death
Attributed to a Public Swimming Pool

Name of Facility: ____________________________
Physical Address: __________________________
City/State/Zip: ____________________________
Contact Person: ____________________________
Contact Telephone Number: (________)

Type of Report: [ ] Death [ ] Serious Injury [ ] Bather complaint of illness

Date of Incident/Onset of Illness: ____________________________

Name of Injured/Complainant: ____________________________
Address: ____________________________
City/State/Zip: ____________________________
Telephone Number: (________)

Description of injury or complaint*: ____________________________
________________________________________
________________________________________
________________________________________
________________________________________

Name(s) and Telephone Number(s) of Person(s) Rendering First Aid or Assistance: ____________________________
________________________________________
________________________________________
________________________________________

Name of Hospital, Rescue Squad, or Physician Providing Medical Treatment: ____________________________
________________________________________
________________________________________
________________________________________

Name(s) and Phone Number(s) of Witnesses to the Incident: ____________________________
________________________________________
________________________________________
________________________________________

* Attach additional sheets as needed to provide complete details of the incident or illness.

The information above must be submitted to the Mecklenburg County Health Department within 2 working days of any accident, injury or death attributed to a public swimming pool. (Reference Title 15A North Carolina Administrative Code 18A .2540) Information may be called in to the office at (704) 336-5100, or the completed form may be faxed to us at (704) 336-5306.
MECKLENBURG COUNTY
Health Department

POOL BARRIER INSPECTION REPORT

Facility Name_________________________________Address_____________________________________Zip_________

Pool ID#___________________ Pool Type: (   )swimming (   )whirlpool (   )wading [pre-4/1/00 __YES __NO]
(   )other:___________________

Fence Type (mark all that apply):
(   )NA(spray pads)           (   )Chain link     (   )Brick/concrete     (   )Metal(wrought iron, aluminum, ___________)
(   )Picket/stockade                (   )Other:______________________________________________

Observations:
1. Barrier(fence) height at least 48” above ground from outside approach ___YES ___NO
   Comments:________________________________________________________________________________
2. Openings under fence to ground surface no more than 4” ___YES ___NO
   Comments:________________________________________________________________________________
3. Openings through fence no greater than 4”spherical dimension ___YES ___NO
   Comments:________________________________________________________________________________
4. Horizontal fence components at least 30” apart or, if closer, no fence through openings >1.75” ___YES ___NO
   Comments:________________________________________________________________________________
5. Footholds, if present, more than 30” above ground from outside approach ___YES ___NO
   Comments:________________________________________________________________________________
6. Decorative cutouts ≤1.75” opening if less than 48” above ground from outside approach ___YES ___NO
   Comments:________________________________________________________________________________
7. Chain link fence openings no more than 2.25” square unless slats present ___YES ___NO
   Comments:________________________________________________________________________________
8. Diagonal fence components, where present, no more than 1.75” apart ___YES ___NO
   Comments:________________________________________________________________________________
9. Gate latch release height at least 54” above ground or, if less, meets #10 ___YES ___NO
   Comments:________________________________________________________________________________
10. Gate latch release by secured entry or located on inside of gate at least 3 “ below top of gate and with no gate or
    fence through opening greater than ½” within 18” of release mechanism ___YES ___NO
   Comments:________________________________________________________________________________
11. Gate swings away from pool ___YES ___NO ___ND
    Comments:________________________________________________________________________________
12. Individual living units adjoining or within the pool area. Includes patios, entryways, etc. ___YES
    Comments:________________________________________________________________________________
13. Non-lifeguarded pools, indoor or adjoining common buildings(e.g. clubhouses) with self-closing doors ___YES ___NO ___ND
    Comments:________________________________________________________________________________

FINDINGS: Pool in compliance with all barrier requirements of State of NC Public Pool rules ___YES ___NO

___________________________________________    _____________________
Health Department Official       Survey date

If the FINDINGS box above is marked “NO”, the listed pool OWNER will be sent written notification of those areas not in
compliance along with information on how to achieve compliance. Notifications will be sent within 30-45 days of the
survey date. All questions should be directed to the Health Department at (704) 336-5101.
Mecklenburg County Health Department
Pool Drain Safety Compliance Data

Facility Name of pool location______________________________________________________Pool ID#__________
Physical Address of pool ______________________________________________City____________________Zip_____

All applicable sections of the form must be completed. Missing or incomplete data or information will result in a DISAPPROVAL of the submission. Facilities should NOT contact the Health Department for this information as it is not maintained in their facility pool file.

1. Pump System Flow(if more than one type of pump on one pool, attach additional sheets with “pump #2, #3”, etc.)
Pump Manufacturer _________________________Model #____________________________HP________
(Complete either A or B below, not both)
A. Maximum Pump Flow (manufacturer’s specs) ___________gallons per minute based on pump performance curve
B. Maximum Pumping System Flow is reduced to _____________ gpm based on either(choose one only):
   Measured Total Dynamic Head loss of _________ feet;
   Calculated Total Dynamic Head loss of _________ feet;
   Magnetic flow meter reading of ____________gpm;
   Automatic flow limiting valve factory set at ________gpm
***Must provide supporting evidence for flow reduction***

2. Drain Sump Measurements(SKIP this section if universal drain cover, approved for sumpless pools, is installed)
Sump size(inside dimensions): _______ inches diameter(if round) _______ inches by( X) _______ inches(if rectangular)
Sump minimum depth __________ inches Diameter of suction outlet pipe to pump ____________ inches
Distance of top (inside) of suction outlet pipe from bottom of cover/grate _____________ inches

3. Drain Cover/grate data(if multiple pumps with multiple drains on 1 pool, attach additional sheets with pump #2, #3, etc. data)
Number of main drains on same pumping system ____ Distance between drains (on centers) ______ inches (“NA” if single drain)
Drain cover manufacturer ___________________________ Model # _________________
Maximum flow rating of cover/grate__________ gpm (floor); __________ gpm (wall)
Number of operable skimmer equalizers________(each surface skimmer usually has ONE equalizer line)
Equalizer fitting manufacturer_____________________________Model #_________________Maximum flow rating(gpm)____
***if equalizer lines are to be BLOCKED, without approved fittings, check block □

4. Suction Vacuum Relief System(SVRS)(if applicable-see instructions)(SKIP this section if drains are more than 3 feet apart)
NOTE-Suction vacuum relief systems are REQUIRED on all pool pumping systems where either a SINGLE main drain is or
where two or more drains, on same pump, are not at least 3 feet apart, measured from the center of the drain.
SVRS manufacturer ________________________________ Model # _____________

Name of person completing_________________________________________________________Title____________________________
(SIGNATURE)                                                                                     Date__________________________     JAN 2010