WHAT DOES A SWIMMING POOL OPERATOR NEED TO KNOW?

1. **POOL VOLUME**

The volume of your pool is the most important number you need to know. The volume is the number of gallons of water in your pool.

a. The size of the pump, filter, chemical feeder, piping, heater, and other related pool equipment are all dependent on the pool volume.

b. The addition of pool chemicals is dependent on the pool volume.

Calculating your pool volume:

Measure the pool length and width in feet. Determine the average depth in feet.

For rectangular pools: Length x Width x Average Depth x 7.48 = Pool Volume in gallons.

For round pools: Diameter x Diameter x Average Depth x 5.87 = Pool Volume in gallons.

For other shape pools: Surface Area x Average Depth x 7.48 = Pool Volume in gallons.

2. **POOL FLOW RATE**

The flow rate of your pool is also very important. The flow rate is the amount of water that flows through your pool in a set time period. It is measured in gallons per minute (gpm).

a. The size of most pool equipment is dependent on the flow rate also.

b. Water quality and clarity are dependent on flow rate.

Calculating your pool flow rate:

Pool Volume/Turnover Period/60=Flow Rate in gallons per minute.

Turnover Period for pools:	Required	Preferred
Swimming Pools	8 hours or less	6 hours or less
Wading Pools	2 hours or less	1 hour or less
Spa Pools	1 hour or less	0.5 hours or less

Required flow rate for pools with skimmers: Number of Skimmers x 37.5 = Required Flow Rate in gallons per minute.

3. **BASIC POOL EQUIPMENT**

You must know the basic purpose for each component of your pool filtration system. Recirculation, filtration, disinfection, and other equipment are all used to maintain pool water quality and clarity.

a. Recirculation Equipment
   (1) The pump is the heart of the pool system causing water to flow at the proper rate.
   (2) Skimmers or gutters remove the contaminated pool water from the pool water surface.
   (3) Main drains remove water and settled debris from the pool bottom.
   (4) Piping conveys water to and from the pool.
   (5) Wall or floor inlets uniformly return clean water back to the pool.

b. Filtration Equipment
   (1) The filter removes dirt and other large particles from the pool water. There are 3 general types of filters.
      (a) Sand
      (b) Diatomite
      (c) Cartridge
   (2) Dirt particles get captured in the spaces between sand, diatomite, or cartridge fibers. The filter needs to be periodically cleaned to remove the captured dirt.

c. Disinfection Equipment
   (1) The chemical feeder applies a controlled amount of disinfectant or sanitizer to the pool by either electrically operated pumps or by water erosion.
   (2) The disinfectant destroys bacteria, algae, and other matter, which easily pass through the filter.

d. Other Equipment
   (1) Valves are used to route and adjust the flow of water through the different parts of the piping and system.

(2) The flow meter is used to monitor the actual flow rate in the system.
(3) Pressure gauges are used primarily to monitor the cleanliness of the filter.

4. **DISINFECTION**

Disinfection is the chemical process of destroying potentially harmful organisms not removed by filtration that could be found in your pool water. A disinfectant is needed at a very low, but detectable levels to be effective. The effective level of disinfection is in the parts per million (ppm) range.

a. Minimum Free Available Disinfection Residuals

	pH	
Disinfenctant	7.2 – 7.6	7.7 - 8.0
Bromine	1.0 ppm	2.0 ppm
Chlorine	0.4 ppm	1.0 ppm
Chlorinated Cyanurate	1.0 ppm	1.5 ppm

b. The chemicals used in disinfection are in liquid, granular, or tableted form.
c. The disinfectant chemical is required to be fed by a chemical feeder for normal pool disinfection.
d. The free available chlorine residual is measured by using a test kit that allows the comparison of a pool water sample color with the color of a kit standard with a known ppm level.
e. Test kit chemicals must be stored properly and be replaced annually.

5. **pH**

pH is the measure of how acid or alkaline your pool water is. This property of water is extrmely important since it directly affects bather comfort and the effectiveness of any chemical added to the pool.

a. pH is required to be maintained between 7.2 and 8.0.
b. The best pH for any pool is 7.4 to 7.6.
c. A high pH greatly reduces chlorine effectiveness. A high pH has less effect of bromine effectiveness.
d. A low or high pH is irritating to swimmers.
e. A low pH is corrosive to pool and equipment surfaces.
f. A high pH can allow the formation of damaging scaling on pool and equipment surfaces.
g. All pool chemicals and fresh water will affect the pool pH in some way.

6. **SUPER CHLORINATION**

During conditions of high bather load and generally lower pH. chlorine and bromine readily combine with nitrogen in your swimming pool water instead of doing the work of disinfection.

a. The nitrogen is from swimmer's bodily waste products.
b. The compounds formed are called chloramines and cause unpleasant, chlorine-like odors and eye irritations.
c. Large doses of chlorine or other compounds are needed to remove chloramines.
d. A test kit is used to measure the total chlorine residual. If the difference between the total and the free risiduals is greater than or equal to 0.3 ppm, these chloramines need to be removed.
e. A dosage of ten times the chloramine residual needs to be added to the pool at one time to remove the chloramine. A period of 6 or more hours is needed for the reaction to take place.
f. Normally, the excess chlorine residual will dissipate during this time period. However, if the chlorine residual is above about 5.0 ppm after reaction, a dechlorinating chemical may be used to bring the residual down to a more suitable level.

Please contact the Michigan Department of Community Health, Public Swimming Pool Program if you have any questions. Our phone number is 517-335-8296

SWIMMING POOL CHEMICALS

1. **DISINFECTION** Range: 0.4 – 3.0 ppm Ideal: Pools 1.0 ppm Spas 3.0 ppm

Chemical	Form	% Available Chlorine	Solution pH	Approximate Dosage for 1 ppm	Approximate Dosage for 10 ppm
Chlorine					
Chlorine gas*	gas	100	0-2	1 oz/7,500 gal	1 lb/12,000 gal
Sodium Hypochlorite	liquid	12	13-14	1 fl oz/900 gal	1 gal/12,000 gal
Calcium Hypochlorite	granular of tablet	65	12-13	1 oz/4,900 gal	1 lb/7,800 gal
Lithium Hypochlorite	granular	35	10.5	1 oz/2,600 gal	1 lb/4,200 gal
Chlorinated Cyanurates					
Sodium dichloro-s-triazine trlone	granular	56	6-7	1 oz/4,200 gal	1 lb/6,700 gal
Trichloro-s-triazine trlone	tablet	90	2-3	1 oz/6,700 gal	1 lb/10,700 gal
Bormine					
Bromo-chloro-dimethyl hydantoin	stick or tablet	65Br	6-7	1 oz/4,900 gal	1 lb/7,800 gal

*Requires specific approval in writing

Superchlorination

Periodic superchlorination is highly recommended. Increase the free chlorine residual to 5-10 ppm for several hours and allow the level to fall to 3 ppm before allowing swimming again. This should be done at night or when the pool is not being used. Superchlorinate weekly to monthly or when necessary. Always correct the pH before and after this process.

Shock Treatment of Breakpoint Chlorination

Breakpoint chlorination is needed to remove unwanted combined chlorine or chloramines from pool water. Chloramines form when ammonia from swimmers combines with free chlorine in the pool. Chloramines are poor disinectants and cause eye irritation, skin discomfort, and chlorine-like odors at a pool. To achieve breakpoint chlorination, the point at which free chlorine is reformed, a large dose of chlorine must be added to the pool. The dosage is 10 times the combined chlorine residual. For example, if the combined chlorine residual in the pool is 1 ppm, a 10 ppm dosage of 1 gallon of sodium hypochlorite per 12,000 gallons of pool water must be added to the pool to reach breakpoint. Any less than this dosage will be ineffective in removing any of the chloramines.

Disinfectant Neutralization

To neutralize or eliminate a 1.0 ppm free chlorine residual:

Chemical	Add
Sodium bisulfate	1.46 ppm or 2.4 oz/10,000 gal
Sodium sulfite	1.77 ppm or 2.9 oz/10,000 gal
Sodium thiosulfate	0.70 ppm or 1.9 oz/10,000 gal

2. **pH CONTROL** Range: 7.2 – 8.0 Ideal: 7.4 – 7.6

Chemical	Form	Solution pH	Effective	Approximate Dosage
Acid				
Sodium bisulfate	Powder	1.5 (in water)	Lower pH	See Table 1
Muriatic acid	Liquid	1.0	Lower pH	See Table 1
Base				
Soda Ash	Powder	11.0	Raise pH 0.3	1 lb/10,000 gal.
Baking Soda	Powder	8.4	Raise pH 0.1 (pH 8.4 max)	1 lb/10,000 gal.

Water has a major impact on the pool pH, and can raise or lower the pH depending on the pH of the make-up water and the amount of water being used.

Adding 1 ¼ lbs. of sodium bisulfate has the equivalent effect as adding 1 pint of muriatic acid.

To neutralize the pH effect of:

Chemical	Add
1 lb. chlorine gas	1.5 lb. soda ash
1 gal sodium hypochlorite	8.4 oz. sodium bisulfate or 5 fl. oz. muriatic acid
1 lb. calcium hypochlorite	3.3 oz. sodium bisulfate or 3 fl. oz. muriatic acid
1 lb. cyanuric acid (stabilizer)	5.3 oz. soda ash
1 lb. lithium hypochlorite	1.8 oz. sodium bisulfate or 1.5 fl. oz. muriatic acid

3. **STABILIZER** Range: 20 – 100 ppm Ideal: 30 – 40 ppm

Cyanuric acid is the stabilizer used to prevent the reduction of free chlorine residual by ultraviolet degradation (sunlight). A dosage of 1 ½ lb/5000 gallon of pool water is equal to 36 ppm. A 95% reduction of free chlorine residual occurs in about 4 hours on an 80-degree F. sunny day without stabilization. With a 30 ppm cyanuric acid level, less that 15% reduction of the residual occurs in 24 hours.

There is little or no purpose for stabilization of an indoor pool since ultraviolet radiation does not penetrate glass or other enclosure materials. Stabilization has no effect on bromine disinfected pools. The cyanurate residual can only be lowered by water dilution.

4. **ALKALINITY CONTROL** Range: 75 – 125 ppm Ideal: 100 ppm

Alkalinity is a measurement of the buffer capacity of the pool water. Buffer capacity acts as a “shock absorger” for the pH. A low alkalinity allows wild fluctuations of the pH with small additions of pH correction chemicals. A high alkalinity in effect prevents pH changes even with large additions of pH correction chemicals. A high alkalinity also will try to keep the pH at about 8.4.

Chemical	Form	Use	Approximate Dosage for 10 ppm Change
Sodium bicarbonate	Powder	Raise alkalinity	1.5 lb/10,000 gal.
Soda ash	Powder	Raise alkalinity	1.6 lb/10,000 gal.
Muriatic acid	Liquid	Lower alkalinity	1.4 pts/10,000 gal.
Socium bisulfate	Powder	Lower alkalinity	1.6 lb/10,000 gal.

Table 1

Acid Addition for pH Reduction

The following table is a guide for lowering the pH of swimming pool water. The numbers listed are the amounts of acid needed per 1000 gallons of pool volume. Acid must never be added to the pool in larger doses than ½ gallon per day. Acid also must never be added to the pool when bathers are present or expected within an hour. Acid should be spread around the pool to allow proper mixing.

Present pH	Desired pH (Muriatic acid (fl.oz.))				Desired pH (Sodium bisulfate (oz.))			
	7.0	7.5	8.0	8.5	7.0	7.5	8.0	8.5
7.5	8.0	-	-	-	1.0	-	-	-
8.0	1.1	0.3	-	-	1.4	0.4	-	-
8.5	1.3	0.6	0.2	-	1.6	0.8	0.3	-
9.0	1.8	1.0	0.7	0.5	2.3	1.3	0.9	0.6
9.5	3.2	2.5	2.1	1.9	4.0	3.1	2.6	2.4
10.0	5.5	4.7	4.4	4.1	6.9	5.9	5.5	5.1

This table is designed for and is most accurate at a total alkalinity of about 100 ppm. If the alkalinity is higher (>120 ppm) the amount of acid will need to be increased significantly to lower the pH to the desired level.

Example 1: If a pool is 30,000 gallons and at pH 0.0, to lower the pH to 7.5:
add $\frac{1.0 \text{ fl. oz}}{1000 \text{ gal.}}$ x 30,000 gallons – 30 fl.oz. muriatic acid

or add $\frac{1.3 \text{ oz.}}{1000 \text{ gal.}}$ x 30,000 gallons = 39 oz. sodium bisulfate

Example 2: If a pool is 213,300 gallons and at pH 8.5, to lower the pH to 7.5:
add $\frac{0.6 \text{ fl. oz}}{1000 \text{ gal.}}$ x 213,300 gallons – 128 fl. oz. or 1 gallon muriatic acid

Example 3: If a spa is 400 gallons and at pH 8.0, to lower the pH to 7.0:
add $\frac{1.4 \text{ oz}}{1000 \text{ gal.}}$ x 400 gallons – 0.6 oz. sodium bisulfate

Example 4: If a pool is 125,000 gallons and at pH 8.0, to lower the pH to 7.5:
add $\frac{0.4 \text{ oz}}{1000 \text{ gal.}}$ x 125,000 gallons – 50 oz. sodium bisulfate

Reference: White, Geo. Clifford, “Handbook of Chlorination”. Ch. 8, p. 497, Van Nostrand Reinhold Company, New York (1972)

5. **HARDNESS CONTROL** Range: 100 – 400 ppm Ideal: 250 ppm

Hardness is the measurement of calcium and magnesium ions in the pool water. This measurement is so named because large amounts of these ions makes it "hard" for soap to make suds in water. Water seems to demand a certain amount of these ions to keep a proper balance. Soft water can contribute to the corrosion of pool walls, piping, and other equipment in contact with the pool water. Hard water can contribute to the formation of scale in piping and other pool surfaces, as well as some staining.

Chemical	Form	Use	Dosage
Calcium chloride	Powder	Raise hardness 11 ppm	1 lb/10,000 gal.
Tri sodium phosphate*	Powder	Lower hardness 5 ppm	1 lb/24,000 gal.
Softened water	Liquid	Lower hardness	as needed

*A detergent that causes considerable foaming

6. **ALGAE CONTROL AND ALGAECIDES**

If adequate disinfectant residuals are maintained and periodic super chlorination is practiced, then algaecides are not normally needed. Many algaecides are simply relabeled disinfectants. Several types of separate algaecides are marketed but the companies still recommend adequate disinfection to prevent algae growth.

If an algaecide is to be used, follow the label directions carefully. Do not use too little or too much. Low levels are not effective and high levels are dangerous to swimmers.

Quaternary ammonium compounds are common algaecides in a liquid form and contain from 1 to 20% effective ingredient. The dosage varies around 1 gal/50,000 gallons for an initial treatment of an algae bloom, and 1 qt/50,000 gallons for routine preventative treatment.

These algaecides are not to be used in place of regular disinfectants as they are ineffective against many bacteria, cause foaming when used at moderate dosages, add to the combined chlorine residuals, are eye and mucous membrane irritants, and can react dangerously with soaps and detergents.

Copper based algaecides are another common form of algaecide. Copper triethanolamine, copper sulfate, copper citrate, copper gluconate, and cupric carbonate or malachite are common active ingredients.

Another active ingredient in algaecides include poly (oxyethylene (dimethyliminio) ethylene (dimethlyiminio) ethylene dichloride) (that's all one name). This particular algaecide does not cause foaming, but is toxic to fish, so proper disposal is necessary. Simazine, colloidal silver, and sodium dimethyl dithlo carbonarte are other active ingredients in algaecides. Phenyl mercuric acetate was perhaps the most effective algaecide until it was banned because of mercury content.

7. **OTHER CHEMICALS**

Chemical	Use	Effect
Aluminum sulfate (alum)	Coagulant	Removes suspended solids and Cu, Fe, Ca, Mn
Copper ethylene diamine tetra acetate (EDTA)	Sequesterant	Removes Ca, Fe, Mg