LOS ANGELES COUNTY - DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENT HEALTH
RECREATIONAL WATERS PROGRAM

SWIMMING POOL SERVICE TECHNICIAN'S STUDY GUIDE

DISINFECTION

Swimmers bring into a pool every kind of contaminate existing on and in their bodies. Some common contaminates are urine, feces, sputum, bacteria, viruses, fungus and other organisms, cosmetics and toiletries. Sometimes contaminates in pool water can cause illness in susceptible people. Diseases such as Hepatitis A, Norwalk Virus, and a variety of skin infections can be transmitted through pool water. A common complaint called swimming pool rash (swimmer's itch) is caused by the Pseudomonas bacteria. Parasites such as Giardia and Cryptosporidium can also be easily transmitted through pool water. Disinfection destroys many of these contaminates and helps keep the pool safe for swimmers.

Chlorine and bromine are the most common products used to disinfect swimming pools. The pH of pool water is one factor that determines how effectively these products disinfect pool water. When chlorine is added to pool water, it forms hypochlorous acid and hydrochloric acid. The chemical equation for this reaction is: $Cl_2 + H_2O \rightarrow HOCl + HCl$. Hypochlorous acid is a very effective disinfectant. Hydrochloric acid is a by-product of the reaction and is not an effective disinfectant. Hypochlorous acid is measured as free-chlorine residual. Depending on the pH, hypochlorous acid may separate into hydrogen ions and hypochlorite anions. The chemical equation for this reaction is: $HOCl \leftarrow \rightarrow H^+ + OCl^-$. The more acidic the pH, more hypochlorous acid remains in the water and more disinfection takes place. The more alkaline the pH, the more hydrogen Ions and hypochlorite anions form resulting in less disinfection.

Chlorine combines with nitrogen compounds such as ammonia in pool water, to form chloramines or combined chlorine. Ammonia combines with hypochlorous acid to form monochloramine and water. The chemical equation for this reaction is: $NH_3 + HOCl \rightarrow NH_2Cl + H_2O$.
Other chemical reactions can form additional chloramines such as dichloramine and nitrogen trichloride. Combined chlorine is a weak disinfectant which imparts a strong chlorine odor and irritates the eyes. Therefore it is desirable to have as little combined chlorine in the pool as possible. Predictably, combined chlorine forms more rapidly when large numbers of swimmers are in the pool. The California Code of Regulations, Title 22 requires maintaining the maximum combined chlorine concentrations at 0.4 ppm or less in a public swimming pool. When the combined chlorine level becomes too high, the pool should be super-chlorinated (shocked). In general, shocking to reach breakpoint is achieved by adding to the pool water an amount of free chlorine equal to 10 times the combined chlorine level present in the pool. The combined chlorine is destroyed (breakpoint) leaving essentially free chlorine in the pool. Pools that have been super-chlorinated should be allowed to return to normal chlorine levels before being used. Title 22 requires that the free-chlorine residual in a public swimming pool be kept at 1.0 ppm to 10.0 ppm in pools not using stabilizer, and 2.0 ppm to 10.0 ppm in pools using stabilizer.

Sodium hypochlorite (liquid chlorine) has approximately 10 - 15% available chlorine and a pH of 13.0 or greater. Therefore regular use of liquid chlorine requires the addition of an acid to lower the pH. Approximately 8 ounces of acid will neutralize one gallon of liquid chlorine. Advantages of using liquid chlorine are low cost, easily stored, minimal danger to the operator, and ease of mixing with pool water. The disadvantages are short shelf-life, increased levels of sodium (salt) in pool water and possible scale formation if the pH is not controlled.

Trichlorisocyanurates and Dichlorisocyanurates (Trichlor and Dichlor) are organic chlorine compounds. In these compounds, chlorine molecules are attached to molecules of cyanuric acid (stabilizer). Trichlor has 90%

available chlorine and a pH of 2.0 - 3.0. Dichlor has 60 - 65% available chlorine and a pH of 6.8. Therefore regular use of Trichlor or Dichlor requires the addition of an alkaline, such as soda ash, to raise the pH.

Gas chlorine has 100% available chlorine and an extremely low pH. Therefore it is necessary to continually add an alkaline, such as soda ash or caustic soda, into the pool to maintain the pH. It is a light green gas which is 2½ times heavier than air. It is extremely toxic and can only be used at public pools under strict conditions as specified in The California Code of Regulations, Title 24. Small leaks of chlorine gas can be detected using a 26 Baume (density scale) solution of ammonia that produces white smoke. Large leaks should only be repaired using an approved self-contained breathing apparatus. Advantages of using gas chlorine are low cost, indefinite shelf-life and effective disinfection and oxidizing properties. The major disadvantage is the dangers associated with use of the product. Very few public pools in Los Angeles County use gas chlorine for disinfection.

Calcium hypochlorite is a dry chlorine product with 65% available chlorine and an alkaline pH. The advantage in using this product is its stability. However, using calcium hypochlorite increases calcium hardness in the pool and the product must be pre-mixed before adding it to pool water to prevent separation.

Lithium hypochlorite is a dry and stable compound commercially available at 35% available chlorine and has an alkaline pH. It is often used to super-chlorinate a pool. The disadvantages are high cost and relative short shelf-life at high temperatures.

It is important to note that chlorine products are strong oxidizers. Chlorine products should never be mixed together or with other chemicals. Mixing chlorine products together may cause an explosion or fire. Mixing an acid with a chlorine product will result in the formation of deadly chlorine gas. All chemicals should be stored in its original, labeled packaging according to the manufacturer's instructions and the requirements of law.

Chlorine degrades rapidly in the sun. To prevent this, it is advisable to use cyanuric acid as a stabilizer. This slightly acidic product forms a temporary bond with the chlorine molecule until it is needed for disinfection. Title 22 requires that the cyanuric acid be kept between 0.0 ppm and 100 ppm in public pools. For maximum protection from the sun, cyanuric acid should be maintained between 40 - 60 ppm. Levels below 25 ppm are ineffective, and higher than recommended levels are not cost effective. Excessive levels of cyanuric acid can interfere with the disinfection properties of chlorine. The only way to reduce high levels of stabilizer is to partially drain and refill the pool with clean water. It is recommended to add cyanuric acid through the skimmer as needed. The filters should not be backwashed for several days after adding cyanuric acid.

Bromine may also be used as a disinfectant in public swimming pools. In its elemental form, bromine is a reddish-brown liquid approximately three times heavier than water. Bromine liquid is extremely dangerous to handle. Hydantoin bromine is a safer form of bromine and is available in sticks or tablets. Bromine has several advantages over chlorine. It is an excellent disinfectant and does not produce an objectionable odor or eye irritation. Bromine is also a more effective disinfectant across a wider range of pH than is chlorine. Bromine's major disadvantage is its high cost. Title 22 requires bromine levels shall be kept at a minimum of 2.0 ppm in public swimming pools and 4.0 ppm in public spas, wading pools and spray grounds.

Title 24 requires the installation of automatic disinfectant feeders on all public swimming pools. These devices continually dispense a small amount of disinfectant into the recirculation system. Automatic chlorinators commonly are available as a positive displacement type pump which utilizes a reservoir, or an erosion-type feeder. A positive displacement pump is connected to a timer which pumps the liquid solution directly into the recirculation system. Erosion-type chlorinators are connected to the recirculation system at two points with different pressure levels. As a result, recirculation water flows into the chlorinator, dissolving the chlorine tablets and the mixture is piped into the recirculation system. Bromine tablets or sticks can be used in an erosion-type feeder called a brominator. Automatic disinfectant dispensers should be periodically disassembled and cleaned with dilute muriatic acid. Floating dispensers or disinfectant tablets placed in skimmers are not permitted in public pools.
Title 22 requires daily testing for the level of disinfectant in public pool water. There are many types of test kits available on the market, but only DPD test kits or a test kit that is capable of testing free-halogen residual may

be used in public pools. It is important to note that high halogen levels may cause inaccurate results for the DPD test kit and determination of pH and total alkalinity.

WATER BALANCE

Water balance is the relationship of pool chemicals in the water. The ideal pool water provides a comfortable environment for the swimmer while resisting the growth of pathogens, algae and other organisms. The components of water balance are temperature, pH, total alkalinity, total hardness, and total dissolved solids (TDS). The pH scale means "the potential for hydrogen", and is a measurement of acidity or alkalinity in any substance. PH is measured on a scale numbered from 0 to 14. As the pH of swimming pool water is lowered from 7 to 0, the more acidic it becomes. Acidic pool water can cause damage to pool equipment and high levels may injure swimmers. As the pH is raised from 7 to 14, the more alkaline it becomes. Alkaline pool water can cause itchy skin and eyes and cloudy water. At pH 7.0, swimming pool water is neutral, neither acidic nor alkaline (basic). Title 22 requires that the pH in a public pool be kept between 7.2 and 7.8. Chlorine disinfects more efficiently at this range of pH. For optimum disinfection however, the pH of pool water should be kept between 7.4 and 7.6. Various chemicals are commonly used to adjust the pH of pool water. Sodium carbonate (soda ash) is used to raise the pH of pool water. It comes in a powdered form and is broadcast into the pool. Sodium hydroxide (caustic soda) is a highly corrosive liquid also used to raise the pH. This product is usually present in pools with large volumes of water where chlorine gas is also used. It is pumped into the recirculation system at a controlled rate using a positive displacement type pump.

Hydrochloric acid (muriatic acid) and sodium bisulfate (dry acid), are used to lower the pH of pool water. No more than one-half quart of liquid acid per 10,000 gallons should be added at one time or the pool equipment may be damaged. One hour should be allowed between half quart doses. The acid should first be diluted in water. When diluting acid, always pour the acid into the water not the reverse. Diluted acid can then be poured into the deep end of the pool, not into the skimmer or shallow end. Excessive acid and low pH in pool water can leach copper from the recirculation piping and heat exchanger. This can cause bluish-green staining of the plaster. It is important to test for copper level if pool water has been in an acidic state for an extended period of time. If the level is over 0.2 ppm, the pool should be partially drained and refilled before adjusting the pH or staining may result.

Total alkalinity stabilizes pH levels in pool water. Total alkalinity is the level of bicarbonate, carbonate and hydroxide alkalinity in the water. At normal pH, most of the alkalinity is in the form of bicarbonate alkalinity. Total alkalinity should be maintained between 80 - 150 ppm in plaster pools and 125 - 175 ppm in non-plaster type pools. Sodium bicarbonate (baking soda) is used to raise the total alkalinity but won't noticeably change the pH.

Total hardness is a measure of the amount of calcium, magnesium and other metal ions in water. However, test kits are actually only measuring calcium hardness. The calcium hardness level in pool water should be kept between 175 and 300 ppm. High calcium levels may lead to the formation of calcium carbonate (scale), which results in rough plaster surfaces, clogged pipes, reduced circulation, heater inefficiency, and eye irritation. To correct high calcium levels, the pool should be partially drained and refilled. Low calcium levels can result in etching and pitting of plaster, and corrosive water. To correct low calcium levels add calcium chloride to the pool water. Low calcium hardness is usually not a problem on the west coast as hard water is the norm.

Another indication of water quality is the level of total dissolved solids (TDS) in the water. TDS is an electrochemical measurement of water's ability to conduct an electrical current. TDS is a measurement of only the charged particles in water. Neutral particles are not measured as TDS. TDS is generally used to indicate when it is necessary to drain the pool. Make-up water coming into a pool may vary in its TDS level. Generally, a swimming pool should be drained when the TDS is greater than 2,000 ppm over its starting TDS. A spa pool should be drained when the TDS is greater than 1,500 ppm over the TDS of the makeup water. Several undesirable conditions can occur in pool water as a result of high TDS including, algae growth despite adequate chlorine residuals and interference with disinfectants. Also high TDS can cause cloudy water despite good filtration and chlorination, false readings on chlorine tests, and eye and skin irritation.

The Saturation Index (Langelier Index) is a scale that indicates if pool water has scaling or etching properties. The factors used to calculate saturation index are pH, water temperature, alkalinity, and calcium hardness. The values of these factors are taken from the table, totaled and the TDS value is subtracted to arrive at the saturation index. A saturation index of 0 indicates the water is balanced. A negative number greater than -0.5 indicates the water may be corrosive to metals in the pool and may etch the pool plaster. A number greater than +0.5 indicates the water may form calcium deposits clogging recirculation pipes and filter grids, and may stain pool plaster.

FILTERS

A swimming pool filter removes organisms, hair, skin, and other particles from the water. The following filters are presented in order of effectiveness. The requirements for all types of filters can be found in Title 24 of the California Code of Regulations.

DIATOMACEOUS EARTH (DE) - Diatomaceous earth filters consist of a plastic frame covered with a cloth element. Diatomaceous earth is made up of the fossil remains of tiny aquatic plants called diatoms. Diatomaceous earth, when added to the pool filter, coats the cloth filter elements. It is the DE that traps the dirt and debris, not the cloth elements. A DE filter should never be used without diatomaceous earth or dirt will clog the cloth elements. If this should happen, the elements should be scrubbed with a non-foaming detergent. The effective area of filters is measured in square feet. The usual amount of earth added to a DE filter is about one half pound per 5 square feet of filter area. The larger the effective area, the longer the filter can run without requiring backwashing. When the pressure gauge reading indicates that the pressure has increased approximately 10 psi over the starting pressure, it is time to backwash the filter. This is accomplished by reversing the flow of water through the filter using a combination of valves or a multiport valve, and flushing the DE along with accumulated dirt to a waste container. Some cities require DE waste to be routed to a separation tank and then to a sanitary sewer or other approved disposal system. From time to time, the filter should be disassembled for a more thorough cleaning. Oils and grease can be removed from filter elements with a non-foaming type detergent. Scale can be removed by using diluted muriatic acid. Persistent high pressure readings on a clean DE filter may be caused by calcification of the filter elements. Title 24 requires DE filters to be sized at not more than 2 gallons per minute per square foot. This means that a 60 sq. ft. filter can have a maximum of 120 gallons per minute flowing through it.

RAPID SAND AND HIGH RATE SAND - These types of filters use varying grades of sand for filtering. As water passes through the layers of sand, contaminates are removed. Most of the filtration occurs on the surface of the sand. These filters are backwashed using the same methods as in DE filters. Water is flushed backwards through the sand filter to a waste container. Backwash water should never be returned to the pool. Rapid sand filters are used on large municipal pools and are much larger than high rate sand filters. The flow through high rate sand filters is much faster than rapid sand filters and consequently is much smaller in size.

CARTRIDGE - Cartridge filters are made of a pleated cloth element. Dirt is trapped on the elements as the water is forced through the filter. When dirty, cartridge filters are taken out of the filter holder and hosed down, scrubbed and disinfected in a chlorine solution. Cartridge filters should be allowed to completely dry before being put back into service. These filters must be disassembled each time the filter needs cleaning. Title 24 of the California Code of Regulations requires that “an additional set of filter elements shall be available for installation while the existing filter elements are cleaned.” Cartridge filters are sized at 0.375 gallons per minute per square foot.

A sight glass may be used to observe the water when backwashing the filter. When the water is clear the backwashing is complete. Frequently a sight glass is not needed because backwash water can be observed at the air-gap between the backwash line and p-trap.

RECIRCULATION

The recirculation system continuously removes water from the pool, filters and disinfects the water and returns the cleaned water back to the pool. The amount of water being filtered (flow rate) is expressed in gallons per minute (gpm). The length of time it takes to filter a volume of water equivalent to the volume of water in the pool is called the turnover time. The turnover time for each type of public swimming pool is regulated by Title 24. The required turnover time for a public swimming pool is 6 hours or less. Public spas shall have a turnover time of one half hour or less. Public wading pools shall have a turnover time of 1 hour or less. To calculate the flow rate required for a 36,000 gallon swimming pool, divide 36,000 by 6 hours multiplied by 60 minutes (36,000 / 60 x 6). In this example the flow rate is 100 gallons per minute. If a 36,000 gallon pool has a flow rate of 100 gpm, it would have a turnover time of 6 hours or (36,000/100 x 60).

Title 22 requires that the pool recirculation system shall be in operation whenever the pool or spa is open or in use. However, the recirculation system should be in use as long as necessary to maintain the water in a clean and clear condition. A pool should never be used if the water becomes so cloudy that the bottom of the pool at the maximum depth is not clearly visible from the deck. A cloudy pool may be closed by the enforcing agent until clarity is restored. If the bottom of the pool is not visible 48 hours following inspection and closure by the enforcing agent, the enforcing agent may order the pool drained.

The weir (flapper or ring) on a skimmer is necessary to provide proper skimming of the surface of the water. Without a weir, skimming doesn't occur. An anti-air lock device within the skimmer prevents air from entering the suction line if the water level drops below the skimmer opening. Skimmer baskets should be cleaned on a regular basis and replaced when broken. Skimmers not connected to the main drain are required to have an equalizer line located below the skimmer opening. The equalizer line prevents air from entering the suction line if the water level gets too low. Skimmers with an equalizer line should have an equalizer valve installed inside the skimmer. This valve normally remains closed allowing full skimming, but opens when the water level is low. Perimeter overflow pools or rim flow skimming systems flow to a surge chamber and are mainly used on larger pools. The surge chamber is used to balance the level of water in the pool and maintain skimming even when large numbers of people enter the pool.

A flow meter is a device that indicates the rate of flow of a recirculation system in gallons per minute. Flow meters are required on all public pools. On small pools, the meter is usually plastic tubes with an indicator weight. On large pools it may be a mechanical gauge resembling an rpm meter on a car. Flow meters are usually installed after the filter to prevent clogging. The flow meter should also be located far enough away from the heater to prevent warping.

PUMPS

Pumps create a vacuum which circulates pool water. The most common type of recirculation pump used on pools is the centrifugal pump. The term total dynamic head in a recirculating system is the measurement of the resistance of the water flowing through pipes and equipment. Pumps are rated in horsepower and are sized using pump curves. A pump curve is a chart showing the various flow rates at different "feet of head". The greater the "feet of head" the less water flows. The shut-off head is the "feet of head" at which there is no flow. In a recirculation system, total dynamic head can be measured by placing a vacuum gauge on the suction side of the pump and a pressure gauge on the discharge side. The readings are converted to pounds per square inch and added together. If a pump is operated without enough water being supplied on the suction side, cavitation occurs. Cavitation is defined as the formation of vapor bubbles within a liquid at low-pressure regions that occur in places where the liquid has been accelerated to high velocities. Cavitation can be identified by a rumbling noise, air bubbles at the discharge pipe and erratic pressure gauge and flowmeter readings. Cavitation causes damage to the impeller and can impair or destroy the pump. This can result in a significant reduction of efficiency because the flow pattern is distorted.

MAINTENANCE

The Los Angeles County Code, Title 11 requires that public and private pools in Los Angeles County shall be serviced by a certified Swimming Pool Service Technician or Technician's Apprentice. It is important to note that the California Business and Practices Law, Section 704, requires a State Contractor's License for any job which totals $500 dollars or more in labor and materials. The applicant should be familiar with all of the requirements regarding pool maintenance in The Los Angeles County Code, Title 11 and The California Code of Regulations, Title 22 and Title 24.

Algae growth in pools may indicate that chlorine residuals are not being continuously maintained. Algae growth is stimulated by hot weather, sunlight, heavy bather loads, insufficient disinfectant, high TDS, rough finishes, and scale formation. Besides being aesthetically undesirable, algae create a slipping hazard and can cloud the water. Algae also create a tremendous disinfectant demand. Eliminate algae growth in pools by brushing the walls and floor with a nylon or stainless steel brush. Pool products are also available that inhibit the growth of algae. Algaecides are chemicals that kill algae. Copper compounds are excellent algaecides but should be chelated to prevent staining of the pool walls and floor. Quaternary ammonium compounds are also used as algaecides but can cause foaming.

Make-up water for a pool shall be from a potable source. The fill line shall have the proper type of backflow protection. Backflow protection prevents the water from the pool from being drawn back into the public water supply. Another method of backflow prevention is a space between two devices called an air-gap. An air-gap is often used on the back wash line connection to the sanitary sewer line to prevent the sewer liquids from entering the pool water.

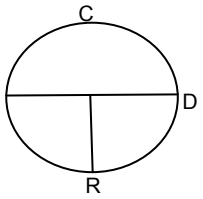
Flocculants and coagulants are chemical products used in pool water to combine small particles of dirt. The larger particles can then be more easily filtered from the pool. Aluminum sulfate (Alum) is a flocculent often added in pools utilizing rapid sand filters. With the proper pH and alkalinity the alum will form a gelatinous floc which will stick to the sand. Particles will then become trapped in the floc.

Sequestrant products are added to pool water to hold minerals and metals in solution and prevent staining of the pool shell.

FORMULAS

Volume of rectangle pool = length x width x average depth x 7.5

Volume of circular pool = radius x radius x 3.14 x average depth x 7.5



Circumference (C) = total perimeter of a circle
Diameter (D) = line drawn from one edge to the other through the midpoint of a circle
Radius(R) = line drawn from the diameter midpoint to the edge of a circle forming a 90° angle

$$\text{Required flow rate} = \frac{\text{pool volume}}{(\text{Turnover time} \times 60)}$$

$$\text{Required filter area} = \frac{\text{flow rate}}{\text{Gpm per sq. ft.}}$$

$$\text{Turnover time} = \frac{\text{gallons}}{(\text{flow rate} \times 60)}$$

Water loss = length x width x (loss in inches/12) x # of days x 7.5

$$\text{Maximum bather load (pool)} = \frac{\text{surface area in sq. ft.}}{20}$$

$$\text{Maximum bather load (spa)} = \frac{\text{Surface Area in sq. ft.}}{10}$$

Total chlorine = combined chlorine + free chlorine

$$\text{Chlorine residual (In ppm)} = \frac{(\text{pounds of product}) \times (\%\ \text{strength}) \times (1{,}000{,}000)}{\text{volume} \times 8.3}$$

Power (watts) = volts x amps

$$\text{Required cyanuric acid} = \frac{\text{ppm desired} \times .083 \times \text{volume}}{10{,}000}$$

Total dynamic head = a. Measure the vacuum pressure at the pump and multiply by 1.13
b. Measure the clean filter pressure and multiply by 2.31
c. Add the two together to get total friction loss in feet of head

Table 1

Desired Increase	Amount Of Cyanuric Acid Needed To Achieve The Desired Increase				
	Pool Volume (Gallons)				
	1000	5000	10000	20000	50000
10 ppm	0.083 lbs.	0.42 lbs.	0.83 lbs.	1.7 lbs.	4.2 lbs.
20 ppm	0.17 lbs.	0.84 lbs.	1.6 lbs.	3.4 lbs.	8.4 lbs.
30 ppm	0.25 lbs.	1.3 lbs.	2.5 lbs.	5.1 lbs.	12.6 lbs.
40 ppm	0.33 lbs.	1.7 lbs.	3.3 lbs.	6.8 lbs.	16.8 lbs.
50 ppm	0.42 lbs.	2.1 lbs.	4.2 lbs.	8.5 lbs.	21.0 lbs.

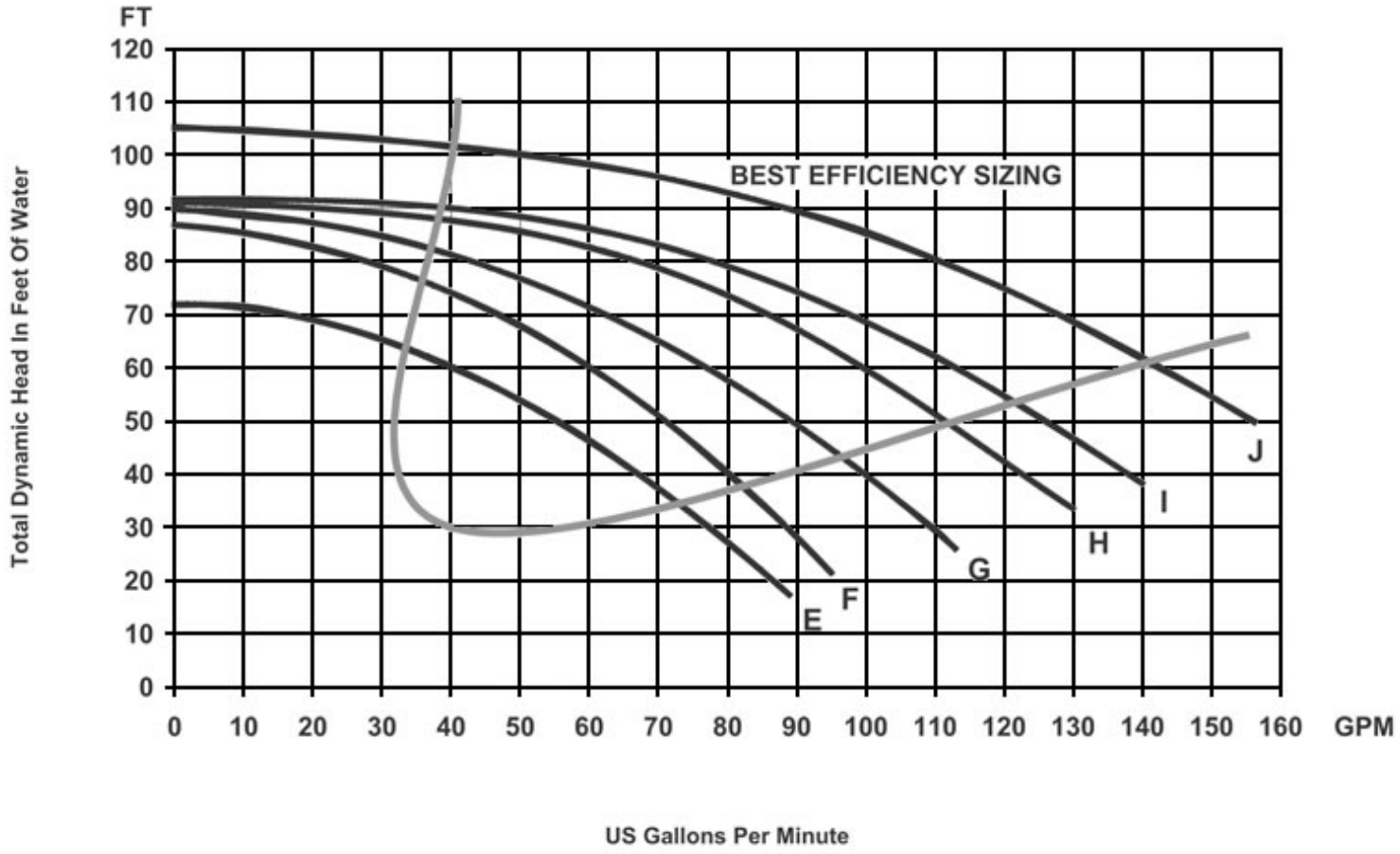
Table 2

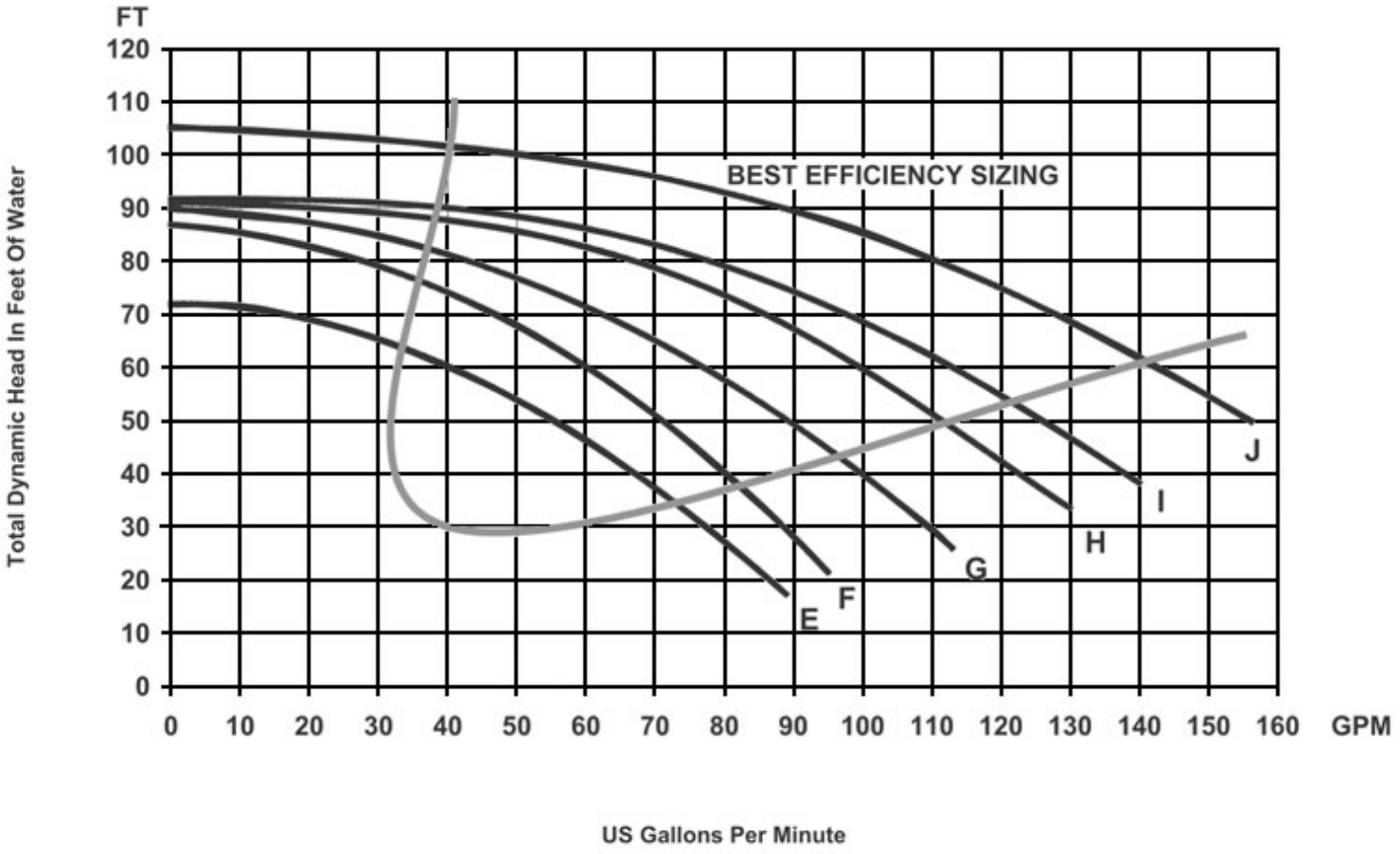
Desired Chlorine Level	Amount In Pounds (Lb.) Of Lithium Hypochlorite Required To Achieve The Desired Chlorine Level				
	Pool Volume (Gallons)				
	1000	5000	10000	25000	50000
1 ppm	0.024 lbs.	0.12 lbs.	0.24 lbs.	0.60 lbs.	1.2 lbs.
5 ppm	0.12 lbs.	0.59 lbs.	1.18 lbs.	2.98 lbs.	5.96 lbs.
10 ppm	0.24 lbs.	1.19 lbs.	2.37 lbs.	5.96 lbs.	11.9 lbs.
15 ppm	0.36 lbs.	1.78 lbs.	3.56 lbs.	8.94 lbs.	17.9 lbs.
20 ppm	0.48 lbs.	2.38 lbs.	4.74 lbs.	11.9 lbs.	23.8 lbs.

Table 3

SATURATION INDEX					
TEMPERATURE		CALCIUM HARDNESS		ALKALINITY	
DEGREE F	TF	PPM	CF	PPM	AF
32	0	5	0.3	5	0.7
37	0.1	25	1	25	1.4
46	0.2	50	1.3	50	1.7
53	0.3	75	1.5	75	1.9
60	0.4	100	1.6	100	2
66	0.5	150	1.8	150	2.2
76	0.6	200	1.9	200	2.3
84	0.7	300	2.1	300	2.5
94	0.8	400	2.2	400	2.6
105	0.9	800	2.5	800	2.9
128	1	1000	2.6	1000	3

TDS (<1000 ppm) = 12.1
TDS (≥1000 ppm) = 12.2


FT
120
110
100
90
80
70
60
50
40
30
20
10
0
Total Dynamic Head In Feet Of Water
BEST EFFICIENCY SIZING
J
I
H
G
F
E
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 GPM
US Gallons Per Minute


FT
120
110
100
90
80
70
60
50
40
30
20
10
0
Total Dynamic Head In Feet Of Water
BEST EFFICIENCY SIZING
J
I
H
G
F
E
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 GPM
US Gallons Per Minute

GENERAL INFORMATION

1 gallon of water weighs 8.3 lbs.
1 gallon of liquid chlorine weighs 10.0 lbs.
1 pound per square inch equals 2.31 ft. of water (or feet of head).
1 inch of mercury equals 1.13 ft. of water (or feet of head). .
1 cubic foot equals 7.5 gallons.
1 horsepower equals 746 watts.
2 ounces of muriatic acid lowers the Total Alkalinity of 1,000 gallons of pool water 10 ppm.
0.083 lbs. of cyanuric acid raises the CYA level of 1,000 gallons of pool water 10 ppm.
0.15 lbs. of sodium bicarbonate raises the Total Alkalinity of 1,000 gallons of pool water 10 ppm.
16 ounces = 1 pint (pt.)
16 ounces = 1 pound (lb.)
$A = \pi r^2$

DISCLAIMER

This study guide comprises a general outline of public swimming pool function, equipment and maintenance but does not supersede the requirements of law. The most current Federal and State Laws and the Los Angeles County Codes are the authority regarding construction and maintenance of public swimming pools.