

**POOL &**

**SPA**

**OPERATOR'S**

**MANUAL**

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## TO THE READER

This manual has been slightly modified from one use by the Lexington-Fayette County Health Department for pool and spa operator's certification. It provides practical information about pool and spa management for use by local health personnel. The reader should also consult the 1987 "Kentucky Public Swimming & Bathing Facilities Regulation."

## I. INTRODUCTION

Since man normally does not live in an aquatic environment, he is potentially at risk each time he consumes or has bodily contact with water. Diseases such as typhoid and paratyphoid fever, amoebic dysentery leptospirosis, and bacillary dysentery, which are sometimes associated with contaminated drinking water, can also be spread through contact with the contaminated water of swimming pools. In addition, the swimming pool and surrounding areas are often a source of injuries and frequently play a role in the transmission of infections of the eye, ear, nose and throat, and in the spread of athlete's foot, impetigo, and other dermatoses. In light of these considerations, the proper construction and maintenance of public swimming pools is a public health concern of great importance.

Current epidemiologic evidence indicates that well constructed and operated swimming pools and other public bathing places are not a major public health problem, but potentially they could become one. Some of the diseases of concern are:

1. Intestinal diseases- Typhoid fever, paratyphoid fever, amoebic dysentery, leptospirosis, and bacillary dysentery can be a problem where swimming waters are polluted by domestic or animal sewage or waste. Swimming pools have been implicated in outbreaks of leptospirosis in Wyoming, Idaho, and Georgia.
2. Respiratory diseases- Colds, sinusitis, and septic sore throat can spread more readily in swimming areas due to close contact, coupled with lowered resistance due to exertion.
3. Eye, ear, nose, throat, and skin infections- The exposure of delicate mucous membranes, the movement of harmful organisms into ear and nasal passages, the excessive use of water treatment chemicals, and the presence of harmful agents in the water can contribute to eye, ear, nose, throat, and skin infections. Close physical contact and the presence of fomites also help to spread athlete's foot, impetigo, and dermatitis.

It has been well documented by scientific methods that Staphylococcus and Pseudomonas infections have been contracted from spa pools. The question has recently been raised whether or not genital herpes can be caught from spas. This controversy has yet to be resolved. The herpes virus cannot survive very long away from the human body. Recent data suggest the virus might be able to survive longer in warm moist areas such as wet towels. Although there is no good evidence that the virus is actually spread this way, it is probably advisable for people with active lesions to use their own towels.

The list of diseases spread by contaminated water is quite long. It includes impetigo, typhoid fever, amoebic dysentery, leptospirosis, and bacillary dysentery. The organism of particular concern in spa pools is the bacterium, *Pseudomonas aeruginosa*, which cause swimmer's ear and skin rashes (folliculitis). The organism *Pseudomonas* is very resistant to chlorine and has been isolated from water containing a 2 ppm free chlorine residual at a pH of 7.4. Whereas most bacteria die at 104 F, *Pseudomonas* survives water temperatures up to 110 F.

The standards for bacteriological quality of pool and spa water are stated in Section 19 of the Kentucky Swimming and Bathing Facilities Regulation. In general three consecutive positive samples in which the bacteria count exceeds the maximum allowable, constitutes grounds for closing.

Spas and hot tubs are relatively recent developments on the American Scene. Other cultures such as the ancient Romans with their public baths and the modern Japanese, realized long ago the physical and psychological benefits of soaking in hot water. Older people with arthritis or certain handicaps, people with injuries, and people who exercise strenuously find the warm water with its energetic movement to be helpful to their muscles and joints.

At first the tendency was to consider them as "little swimming pools." However, experience has taught us that spa pools are considerably different from swimming pools. It has even been suggested that there is reason to consider them as "sewage treatment plants." This is due to the heavy bather loads that these small bodies of water experience. The average apartment pool contains about 30,000 gallons of water. You can see that one person in a 500 gallon spa pool would have much greater effect on water quality than a person in 60 times that much water—the 30,000 gallon apartment pool.

The spa pool environment with its heavy bather loads, high water temperatures, and water agitation is quickly depleted of chlorine residuals and pH stability. Bacteria, algae, fungi and viruses are always present and awaiting the opportunity to multiply when the conditions are right. Maintaining a public spa pool properly is a difficult task and requires constant vigilance. The most important factor in the successful operation of a public spa pool is the presence of a trained and conscientious operator.

This manual has been prepared to assist in the training of pool and spa operators in the areas of sanitation, equipment operations, and safety.

## II. POOL AND SPA TURNOVER

1. The number of gallons in the pool must be known so that the proper amount of chemicals can be added and the correct pump rate determined. The calculation for pool volume in gallons is: Gallons of water = length (in feet) x width (in feet) x average depth (in feet) x 7.5. For example, a pool 40 feet long, 20 feet wide, and an average of 4 feet deep would contain (40 x 20 x 4 x 7.5) 24,000 gallons.
2. 24 hours a day, water is withdrawn from the pool, filtered, and chlorinated, and pumped back into the pool. The pool water will be kept clean and sanitary only if the speed at which this is done is fast enough.

Type of Facility	Turnover Required
Diving Pools	8 hours or less
Wading Pools, Spas	30 minutes or less
Water Slides, Handicap Pools	2 hours or less
All other pools	6 hours or less

The flow meter measures this rate of flow in gallons per minute (gpm). For example:

If your pool holds:	The flow meter should read at least:	
	For 8 Hr. Turnover	For 6 Hr. Turnover
25,000 gallons	52 gpm	70 gpm
30,000 gallons	63 gpm	83 gpm
35,000 gallons	73 gpm	97 gpm
40,000 gallons	83 gpm	111 gpm
45,000 gallons	94 gpm	125 gpm
50,000 gallons	104 gpm	139 gpm
100,000 gallons	208 gpm	278 gpm

3. A Water Company sells water at about \$1.60 per 1,000 gallons (1982 price). It would cost about \$40.00 to fill a 24,000 gallon pool. Spas should be completely drained at least once a week.
4. To protect the drinking water supply, do not allow the end of a garden hose to be stuck in the chemical mixing container or into the swimming pool or spa. If the water pressure dropped, chemicals or pool water could be sucked back into the drinking water supply. Likewise, the backwash pipe must not directly connect with the sewer, to prevent a sewage backup from getting into the pool.

5. In pressure DE Systems the hair and lint strainer is located just before the pump and prevents debris from damaging the pump impeller. Debris must be removed from the strainer basket before backwashing the filter and after the pool is vacuumed if the main pump is utilized for this purpose. A hole or loose fitting on the suction side of the pump will cause air bubbles in the system. Likewise a hole or loose fitting on the pressure side of the pump will leak water.
6. Water is continuously removed from the bottom of the pool through the drain and from the surface by either skimmers or scum gutters in large pools.
7. As water is removed from the very top layer of the water surface, a great deal of the bacteria, suntan lotion, perspiration, leaves, bugs, etc. are also removed. In order for a skimmer to operate properly it must have a strainer basket, a floating weir door, and the equalizer line must have a valve or be plugged. In order for a scum gutter to operate properly, the pool water level must be right at the lip of the gutter so that waves can wash into the gutter yet not fill the gutter full. Maintenance of skimmers and scum gutters includes removing accumulated debris and cleaning the interior when necessary.
8. Water is continuously put back into the pool through inlets that are evenly distributed around the pool bottom or walls. If air bubbles can be seen coming from the inlets, there is an air leak into the suction piping that needs repair.
9. Clean, chlorinated water must enter the pool in such a manner that it quickly mixes with and disinfects water in every part of the pool. To achieve this, it may be necessary to adjust the amount of water coming through each inlet. Inlets nearest to the pump often deliver too large a portion of the treated water. This shows up as a higher chlorine level in that end of the pool.
10. Likewise, water must be removed, from the pool in an efficient manner. Most pools should have 80% of the water removed by the skimmer or scum gutter and 20% removed by the drain during normal operation. This is accomplished by regulation the appropriate valves in the equipment room. Flow through the skimmers can be equalized by closing down the regulator plate in the bottom of the strongest skimmer. If the prevailing wind blows most of the surface film to one end of the pool, you may wish to increase skimming action at that end.
11. Part of the enjoyment of a spa is the sensation of water movement. Water movement is also critical to the sanitation of a spa. Spa water must be filtered frequently enough to remove dirt particles and keep the water clear. Also, good flow is necessary for proper skimmer operation. The flow meter is important because it helps determine when to backwash, it indicates if the pool can meet the required turnover rate and it's required by regulation and listed on the inspection sheet. The flow rate is determined by reading the flow meter in gallons per minute (gpm). The flow rate should be great enough so that the equivalent of one pool volume is sent through the filter system at least once per 30 minutes. The filter and

chlorinator must operate twenty-four (24) hours a day for proper sanitation. The higher the flow rate the better, up to the maximum filter design capacity.

You can determine your turnover rate based on your approximate flow meter reading as shown in the following chart:

Gallons	Turn Over Every		
	10 minutes	20 minutes	30 minutes
550	55 gpm	28 gpm	18 gpm
640	64 gpm	32 gpm	21 gpm
850	85 gpm	43 gpm	28 gpm
900	90 gpm	45 gpm	30 gpm
1100	110 gpm	55 gpm	37 gpm
1400	140 gpm	70 gpm	47 gpm
1800	180 gpm	90 gpm	60 gpm
6500	650 gpm	325 gpm	217 gpm

Most spas should have 80% of the water removed by the skimmer (s) and 20% removed by the drain during normal operation. This is accomplished by regulating the appropriate valves in the equipment room.

#### DRAINING THE SPA POOL:

How often should a spa pool be drained? The Health Department recommends that operators drain their spa pools once a week. However, an exercise facility with a large amount of sweaty bodies using a 500 gallon spa pool should probably drain and replace the water everyday. When to drain depends on the number and type of users. A record of each time the water is drained and replaced should be kept on the log sheets.

One formula that has been proposed for determining when to drain a spa pool is given below:

$$\text{Number of gallons in a spa pool} / 4 = \text{Number of people who use before draining}$$

For example, for a 500 gallon spa pool this would be:

$$500 = 125 \text{ people may use the spa pool before draining.}$$

#### SKIMMER AND DRAIN:

The skimmer works effectively at removing floating body oils and bacteria in a water level range of about four (4) inches. If the water level is too low, water cannot enter the skimmer and if it is too high the surface film cannot be removed. Remember that people submerged in a spa make the water level rise and as they leave they will drag out some more water. The water level should be checked several times a day and water added as necessary.

The weir door is a buoyant plastic flap that is designed so that the skimmer will take water only from the pool water surface. It must fit properly in the mouth of the skimmer and move freely to respond to changes in water elevations. It will be pulled down to a level just below the water level if it is functioning properly.

The equalizer pipe line connects one of the holes in the bottom of the skimmer with a hole in the wall of the pool. Its purpose is to protect the pump from burning up in the event that the water level drops below the mouth of the skimmer allowing air to be drawn into the pump. However, under normal conditions you want all the water to come across the weir door. Therefore, a valve is installed in the bottom of the skimmer that opens automatically only in such an emergency. This valve is called the skimmer equalizer valve.

Another component is the basket which will need to be emptied periodically.

The drain in the bottom of the pool also supplies water to the pump. Typically it requires no attention other than to make sure that the grate is unbroken and screwed in place.

The proportion of water drawn from the skimmer versus the main drain can be adjusted by opening or closing the valves on each line. In general the skimmer should draw at least 80% of the pool water with the main drain drawing the remaining 20%. Pools with overflow gutters should be capable of continuously removing at least 100% or more of the pool water through the gutter and returning it to the filter. However, the valves must not be closed down to the point that the flow meter reading is significantly diminished.

The pump impeller could become damaged by debris were it not for the hair and lint catcher or strainer. It is located just before the pump, and is cleaned by taking off the lid, and dumping out the basket found inside. The best time to clean the hair and lint catches is right before the filter is backwashed. This is also a good time to identify and plan corrections for any leaks in the equipment room pipe system before they become more serious. Be sure to check the gasket seal for proper seating of the strainer.

Periodically through the day, open the air bleed-off valve on the top of the filter to remove air accumulation there. If there is always a flow of air into the filter a serviceman should determine the source of any air leaks into the suction piping. Valves and hair and lint catches lid gasket are common sources. Leaks on the suction piping will suck air and do not leak water.

Do not sweep dirt into the drain while you are backwashing or draining the pool. This will not make the dirt go to the sewer but rather it will lodge inside a filter element. Some dirt may be blown back into the pool when the valves are changed back to the filter cycle. Dirt can be removed by sweeping it to the drain during the filter cycle only.

#### CROSS CONNECTIONS:

A cross connection is a situation in which pool water or chlorine solutions threaten to contaminate the drinking water supply. This can happen if a hose is submerged in the pool, a chlorine barrel, or D.E. pot. Contaminated water could be sucked back into the drinking water system under certain

conditions. Likewise there should be an air gap between the backwash discharge pipe and sewer drain.

### III. FILTRATION

All filters to be used required to the National Sanitation Foundation (NSF) stamp.

#### DIATOMACEOUS EARTH FILTERS:

The direction of water flow in pressure filter systems is through the skimmer, pump, filter, and inlets. A diatomaceous earth (abbreviated D.E.) filter utilizes two major components for the removal of particles from the swimming pool water. First there is a closely woven fabric screen called a filter element. Filter elements vary greatly in size and shape and there are several elements in a filter system. If this component were used alone, the pool would become cloudy because only the largest dirt particles could be strained out and oil and dirt would quickly plug up the pores. Therefore, a white powder called diatomaceous earth is added to form a layer about 1/8 of an inch thick on the fabric screen. Water passes readily through this layer but all dirt and oil particles are trapped in the microscopic pores created by the grains of D.E.

Eventually this D.E. layer becomes so clogged that the amount of water that can pass through it is reduced. This causes the flow rate to go down and the pressure gauge to go up.

When the dirt builds up to a certain level, the old D.E. layer must be removed in a process called backwashing and replaced with new. Check the filter manufacturer's recommendation for what pressure your filter should be backwashed at. Most pressure D.E. filters can be operated to pressure gauge readings of 35-40 psi while vacuum D.E. filters must be backwashed at a vacuum of 10-12 inches of mercury. However, flow rates may be reduced to unacceptable levels before these gauge readings are reached. Most pressure D.E. filter permits greater flexibility in designing the filter room because it requires less space and presents more options for location. The diatomaceous earth is held to the fabric by pressure.

The exact procedure for backwashing a pressure filter is different at each pool, but the basic principle is that the flow of water through the filter is reversed, thereby knocking off the D.E. layer and sending it to the sanitary sewer. Backwashing is complete when the water runs clear (within three minutes). Never vacuum the pool bottom while backwashing as this will damage the filter elements.

Vacuum D.E. filters are backwashed by simply draining the tank and spraying the elements with a hose. A vacuum D.E. filter does not need a hair and lint strainer because the filter is on the suction side of the pump. The vacuum D.E. filter can be combined with surge or balancing tanks and is frequently housed in a concrete or metal tank. Frequently, vacuum D.E. filters are set below pool level so that their operation is aided by gravity. The diatomaceous earth is held to the fabric by suction in vacuum filters. New diatomaceous

earth is added to the filter after backwashing equal to about 2 ounces per square foot of filter area. The square feet of filter area is usually written on the filter's name plate.

If your filter has:	You should add about:
36 square feet	72 oz or 4 ½ lbs of D.E.
48 square feet	96 oz or 6 lbs of D.E.
60 square feet	120 oz or 7 ½ lbs of D.E.
72 square feet	144 oz or 9 lbs of D.E.
84 square feet	168 lbs or 10 ½ of D.E.
96 square feet	192 oz or 12 lbs of D.E.

A gallon container will hold about 3 pounds of D.E. Dirt and oil will clog the pores of the filter element if too little D.E. is used. Too much D.E. may clog the spaces between filter elements.

Many D.E. filters become clogged despite proper backwashing and must be taken apart every so often and cleaned with a soft brush and a detergent solution. An acid solution can be used to clean away scale and iron deposits. Check the elements for tears or holes that would pass dirty water or D.E. back into the pool.

In pressure D.E. filters, air may accumulate in the top of the filter tank even if you don't have a serious air leak problem. This air displaces water and this filtration capacity. Periodically release this air by opening the small valve on the top of the filter.

Whenever the pump is stopped, even momentarily, the D.E. layer loosens, shifts, and may drop from the elements. It is best to backwash, and re-coat the elements in this event. Remember that backwashing a pressure filter consumes water from the pool.

Although the exact procedure of backwashing is different for spa's and pools, basically it will involve the following steps:

1. Close the pool or spa to patrons.
2. Turn off the air bubbles and/or jet pumps, the underwater light, and the heater.
3. Sweep the bottom dirt into the main drain.
4. Clean the bathtub ring and skimmer interior.
5. Turn off the pump.
6. Clean out the hair and lint catcher and replace lid.
7. Switch the valves into the backwash cycle.
8. Close the skimmer valve; open the main drain all the way.
9. Turn on the circulation pump.
10. Continue backwashing until the discharge water runs completely clear or if it is time to empty the spa, until the pump is unable to get any more water out to the pool.
11. Turn off the pump and refill the pool to the proper evaluation.
12. Mix the correct amount of new D.E. in the slurry pot with water and stir so that it will flow easily.

13. Change the valves back to the normal recirculation mode.
14. Turn on the pump.
15. Open the air bleed valve on the filter until water spurts out indicating that the filter is full of water, and then close the air bleed valve.
16. Open the recirculation line valve.
17. Close the inlet line valve so that water is shut off going back to the spa and it recirculates between the pump, filter and recirculation line.
18. Open the D.E. pot valve a little bit so that the D.E. slurry can slowly feed into the system.
19. Bleed off the air from the filter tank again and slightly open the inlet line back to the pool to allow the remainder of the D.E. slurry to slowly feed into the system.
20. Close the D.E. slurry valve before air is allowed to be sucked into the system.
21. Open the inlet valve all the way.
22. Close the recirculation line valve so that all filtered water now flows back to the spa or pool.
23. Note the lower pressure gauge reading and the higher flow meter reading.
24. Bleed air off the filter one more time.
25. Turn on the heater and underwater light.

The reason for the recirculation of the D.E. during precoating is to give small particles of D.E. a chance to become part of the D.E. layer by repeated passes through the filter. They can wedge behind larger D.E. particles that do not slip through the pores.

#### SAND FILTERS:

Typically a sand filter system is composed of several large steel tanks containing sand. As water trickles down through the sand, dirt particles are lodged between sand grains and clean water passes on through.

Eventually the sand becomes so clogged that only a reduced amount of water can pass through showing up as a lower flow meter reading. At the same time the difference between influent and effluent pressure gauges increases. When the difference reaches 6 to 8 pounds per square inch, it is time to backwash the filters. This is accomplished by reversing the flow of each filter, one at a time and sending the backwash water to the sanitary sewer. Each filter tank will need backwashing for about 8-10 minutes or until the backwash water is clear.

Failure to backwash often enough will cause the accumulation of dirt, hair, grease, etc., which will destroy the ability of the sand to filter properly. The sand should be inspected at least once a year to identify problems.

Automatic air relief valves must be in good working order or the air that accumulates at the top of the tank will be forced through the sand. This disrupts the filter surface allowing dirty water to pass through.

#### Rapid Sand Pressure Filters:

The percentage of rapid sand filters being installed today is decreasing, but a large number of them are still in use on old and larger pools. Filter rates for rapid sand filters vary considerably, ranging from 1 ½ to 5 gpm per square foot of filter area. For public pool use, accepted flow rate is a maximum of 3 gpm per square foot.

#### Vacuum Sand Filters:

The vacuum (or gravity) sand filter is used on a limited basis in swimming pools. This system of filtering pool water is very effective but not efficient because of the space taken up by the filters. This system is found in older, larger municipal pools. The large, open concrete tanks were convenient for observing flocculation, sand migration, or channeling. Filter rates were as low as 0.5 gallons per square foot of surface area. Often, water was returned to the pool by gravity, and a float-operated valve prevented overflow.

#### High Rate Sand Filters:

High rate sand filters were developed in the 1950's. Reduction in both cost and space requirements for smaller pools motivated their development. Filter rates of 12 to 20 gpm per square foot of surface are created unique design features using principles of operation similar to rapid sand filters. The accepted flow rate is a maximum of 15 gpm sq. ft. or 75% of the NSF listed rate whichever is lesser.

#### CARTRIDGE FILTERS:

Cartridge filters have been used in residential and public pools since the early 1950's. Surface type cartridge have a single layer of filter media made of synthetic fabrics attached in pleats to a cylindrical core. This enables a large surface area to be contained in a small space.

Cartridge filters do have limitations and special cleaning procedures. For public pools they should only be used for indoor pools. The accepted flow rate is a maximum of 0.15 gpm per sq. ft. A duplicate set of clean cartridge is also required.

## IV. CHLORINATION

#### CHLORINE TYPES:

In Kentucky the most commonly used spa or pool disinfectant is chlorine, either in the granular form (calcium hypochlorite, or the increasingly popular liquid chlorine (sodium hypochlorite).

#### Granular Chlorine:

Two common brands of granular chlorine are "HTH" and "Sentry". Other brands may be used if they contain calcium hypochlorite. The granular form has 65% available chlorine, a shelf life of a year or more, and is potentially dangerous if overheated or mixed with a number of other chemicals (oil, gasoline, acid, furniture polish, etc.) Proper storage of

granular chlorine is important. Keep the lid tightly closed. Do not store the containers near water heater or any other source of heat. Remember that granular chlorine is potentially explosive if mixed with other chemicals or overheated. Granular chlorine will also raise the pH of the spa pool water and necessitates the addition of acid to lower pH into the acceptable range (7.2-7.8). Some pools and spas use granular chlorine (calcium hypochlorite) for cleaning or super chlorinating purposes.

A frequent problem associated with the granular form of chlorine is the clogging of chlorinators. This problem can be avoided by pre-mixing the granular chlorine with water the day before use. This will allow sufficient time for the sediments to settle to the bottom of the container. The clear solution can then be poured in the container from which the chlorinator draws its supply. A strainer on the end of the chlorinator suction tube will remove remaining solids which might clog the chlorinator. Remember to clean the screen periodically. Pumping a diluted-acid solution through the chlorinator on a weekly basis will help dissolve deposits left in the chlorinator by the calcium hypochlorite solution. Preventive maintenance on chlorinators is well worth the investment of time because, without a functioning chlorinator, you as a certified operator must close your spa and pool down. Chlorinators must run continuously when the pools open to patrons. Unplugging the chlorinator or use of timers is not acceptable, and is prohibited.

Remember granular chlorine is a hazardous chemical:

It is severely irritating to wet skin or eyes. Immediately wash spilled chlorine from skin or clothes with large amounts of water. It will catch on fire if it is contaminated with any of a large number of chemicals and materials. Do not mix with any other chemical or other chlorine products. Once ignited, granular chlorine burns rapidly and generates very poisonous fumes. Store granular chlorine away from other chemicals with the container lid secured in place to prevent accidental contamination. Dispose of any spilled chlorine by flushing it down a drain. Do not put chlorine in the trash as it might catch on fire.

#### Solution Chlorine:

1. A solution chlorine system consists of a container in which the chlorine is mixed with water and a small chlorinator pump that pumps this solution. How much solution is pumped is regulated by turning a dial on the chlorinator. After running a chlorine test you turn the dial up or down as needed. When you have gained experience, you will learn to anticipate when chlorine usage will be high and turn the chlorinator up ahead of time. If your chlorinator cannot pump solution fast enough during peak times to keep the right amount of chlorine in the water, then you have not been adding enough chlorine to the mixing container when making your solution. Once you determine how much chlorine to add, make certain you add the same amount of water every time. This way the chlorinator dial settings will have meaning from one batch of solution to another

2. When granular chlorine is added to water, a white deposit is formed. This chemical will coat the inside of the chlorinator and lines, eventually stopping the flow of chlorine. The following suggestions will greatly reduce these clogging problems:
- a. Mix the chlorine in one container, allow it to settle, and transfer the clear solution to a second container for the chlorine to pump from.
  - b. Keep the end of the suction tube off the bottom of the solution barrel to prevent bottom deposits from being sucked up into the chlorinator. A filter on the end of the suction tube is helpful but must be cleaned regularly.
  - c. After you have stirred the mixing container, wait until the deposits have settled before turning on the chlorinator. You will need to clean out the container regularly to keep the deposits from getting deep.
  - d. Make the strength of the chlorine solution only as strong as necessary to meet peak demands. The stronger the solution the more likely it will clog the chlorinator.
  - e. The chlorinator system should be cleaned of deposits by letting it pump an acid solution at least once a week. Make the acid solution by slowly adding a quart of acid to clean plastic container containing 2 quarts of water. If the pool pH is above 7.6, stick the end of the suction tube in the acid solution and let it pump into the pool. If the pH is lower or if the pool is small (whirlpools or baby pools), it would be best to pump the solution back into the acid solution container. Use caution when handling acid.
  - f. The chlorinator can be taken apart for cleaning; however, great care must be taken to assure correct re-assembly of components.
  - g. A number of chemicals currently marketed are advertised as preventing clogged chlorinators. Though these products may be effective, they may alter the chemistry of your pool. Always check with this Department for approval of a product use.

#### Liquid Chlorine:

Liquid chlorine has become more popular with operators in recent years. Convenience is one of its major benefits. Typically, liquid chlorine (sodium hypochlorite) contains 10-15% available chlorine. If stored in a dark, cool room, its shelf life is one month. This product will raise pH more than the granular form, requiring the use of more acid for pH adjustment. With the small quantity of water in spa pools, operators often find it necessary to dilute the solution chlorine. This allows for continuous chlorinator use rather than raising the chlorine level too high and then cutting the chlorinator off for long periods. Dilution is not necessary for pools. Remember liquid chlorine has pH around 12.0 so the pH must be balanced by adding acid.

A lid should be kept on the solution container for three reasons. First, it keeps dirt and objects such as the chlorinator from falling in. Second, as the chlorine solution sits in the container, chlorine gas is given off, thereby reducing the strength of the solution if the container is uncovered. Third, the chlorine gas will corrode pumps and other metal equipment in the room if not contained under the lid.

A chlorinator will stop pumping if it loses prime. This may happen when the liquid solution drains out of the chlorinator and the suction tube. To get it going again fill the

tube with solution and lift it so that the solution can be drawn into the chlorinator. Some chlorinators click or make other unusual sounds when they have lost prime.

#### Gas Chlorine:

Gas chlorine is becoming less popular due to the dangers of handling gas cylinders. For economic reasons gas chlorine is used mostly on very large pools. Due to the inherent dangers it should never be used in small pools or spas. Gas chlorine is packaged under pressure in steel cylinders. The pressure enables the regulated flow of chlorine out of the cylinder but also means that chlorine gas will readily leak from valves, fittings, gaskets, and tubes if even a tiny opening is provided.

Inhalation of gas chlorine can cause respiratory injury ranging from irritation to suffocation. Burns to eyes and skin occur at strong concentrations.

Gas chlorine has a characteristic sharp odor even at low concentrations. It is heavier than air and will flow along the ground surface and down hill.

Chlorine cylinders must not be stored in the sun, a hot room, or artificially heated. At temperatures of 158-165 degrees., a plug melts in the cylinder and all the chlorine will rapidly escape creating an extremely hazardous situation.

All chlorine cylinders, both full and empty must be chained or strapped to a rigid support in the vertical position to prevent tipping. The protective valve hood must be kept in place at all times except when actually feeding chlorine. Do not lift the cylinder by the hood or valve stem.

Most chlorine leaks occur when the operator is changing cylinders. To assure a good connection, always use a new washer when hooking up a cylinder. If something doesn't seem quite right with a cylinder, do not use it; have the manufacturer pick it up.

A small bottle of ammonia should be kept in the chlorine room to locate leaks. When fumes from the ammonia solution contact the escaped chlorine gas, they turn white, pinpointing the location of the leak. Never squirt liquid ammonia on the fittings as corrosion will result. Every connection should be checked with ammonia fumes. Leaks get worse, never better because escaping chlorine corrodes and enlarges the edge of a hole.

The valve on a chlorine cylinder opens counterclockwise and closes clockwise. For quick shut off, open the valve only one quarter turn and keep the wrench in place on the valve stem at all times.

If a chlorine leak cannot be stopped by simply closing the valve on the cylinder, evacuate the area affected. Call the Fire Department at 911. They Have the cylinder repair kits, the breathing apparatus, and training to meet such an emergency.

A Self Contained Breathing Apparatus (SCBA) approved by the U.S. Bureau of mines for chlorine service must be stored in an unlocked cabinet located outside the chlorine room. Older installations with gas mask should read the following: A gas mask cannot be relied upon to provide complete protection from the dangers of chlorine. If you have to wear the gas mask to enter a chlorine filled room, remember, no one could come to your aid if you collapse.

On the door of the chlorine room, the following signs must be posted:

1. "Danger Chlorine Gas" in four (4) inch block red letters.
2. The name and phone number of the pool operator, the fire department, and the chlorine manufacturer in two (2) inch block letters.

Typical operation of the gas chlorinator will involve running a chlorine test and turning the chlorine feed rate up or down as needed. Experience will help you anticipate increased chlorine demand ahead of time. Gas chlorine will always cause your pH to fall.

You will have to add about one to one and one-half (1-1 ½) pounds of soda ash (sodium carbonate) for every pound of chlorine you add to the pool to keep the pH up. A soda ash feeder can be set to coincide with the rate of the chlorinator. If the soda ash feeder breaks down, add the soda ash several times a day so that the pH never falls below 7.2

The soda ash feeder should be cleaned of deposits by letting it pump an acid solution at least once a week. Make the acid solution by slowly adding a quart of acid to a clean plastic container containing 2 quarts water. If the pool pH is above 7.6, stick the end of the suction tube in the acid solution and let it pump into the pool. If the pH is lower, it would be best to pump the solution back into the acid solution container. Use caution when handling acid.

#### STABILIZERS:

1. Outdoor pools have difficulty keeping chlorine in the water because ultraviolet rays from sunshine release chlorine gas from water. To prevent this, the use of cyanurates has been widely accepted. The chlorine is held to the cyanurate by a chemical bond that prevents sunlight from dissipating the chlorine so quickly. The chemical used as a chlorine stabilizer is cyanuric acid.
2. Stabilizer is not to be used in indoor pools because its function is protection of chlorine from sunlight.
3. Stabilizer is to be used as a one-time treatment. Do not use on a daily basis.
4. Granular, liquid, or gas chlorine, NOT CHLORINATED CYANURATES, must be used daily for disinfection of pool water and for super chlorination.

5. A Cyanuric acid test kit must be used weekly and results are to be recorded on the log sheets. Cyanurate levels must not exceed 50 parts per million. To lower cyanurate levels which exceed 50 ppm water must be withdrawn from the pool and fresh water added until cyanurate levels are acceptable.
6. With the use of stabilizer, a minimum free chlorine residual of 1.5 must be maintained. Pools not using cyanurates are allowed a minimum free chlorine residual of 1.0.
7. Health Department inspectors will test all outdoor public pools for cyanuric acid.

#### Stabilized Chlorine:

A form of chlorine prohibited in pools is any of the stabilized chlorine products containing trichloroisocyanuric acid or dichloroisocyanuric acid. Cyanuric acid (stabilizer) is only allowed in outdoor pools because of its ability to prevent sunlight from rapidly dissipating the chlorine from pool. Stabilizer is strictly prohibited for indoor use. Be sure that you are not sold any form of chlorine containing cyanuric acid for indoor.

#### CHLORINE CHEMISTRY, SUPERCHLORINATION:

1. The purpose of adding chlorine to pool water is to kill germs. Disease bacteria are introduced into the pool by swimmers. Ear, eye, and skin infections are the most frequent problems, although much more serious diseases like typhoid and dysentery can be carried by pool water. To control the spread of disease, minimum free chlorine have on pool water include disinfection oxidation, and algae control.
2. When the pool is open, chlorine may only be added to the pool by the chlorinator. "Hand feeding" chlorine directly to the pool is prohibited while the pool is open. It is impossible to maintain the correct level of chlorine by "hand feeding". Also, "hand feeding" creates dangerously high chlorine levels in some parts of the pool and no protection from bacteria in other parts of the pool.
3. Unfortunately, the following factors work to remove the germ killing power of chlorine from the swimming pool:
  - a. Sunlight
  - b. Heat
  - c. Perspiration, urine
  - d. High and low pH
  - e. Dirt, leaves, algae, bacteria, cloudy water
  - f. Splashing, wind, rain

Therefore, on hot sunny days with the pool full of people, you can expect very high chlorine usage.

4. Perspiration and urine cause a special problem because they combine with the chlorine to create a new chemical called "combined chlorine". This new chemical:
  - a. does not kill germs well
  - b. burns the eyes
  - c. has a sour chlorine smell
5. To remove this objectionable combined chlorine, the pool must be treated with a large amount of chlorine in a process called super chlorination. Ideally, super chlorination should be done in the evening before a day when the pool will not be in heavy use. This is because the chlorine level will be 5-10 times (5.0 ppm- 10.0 ppm) normal and may irritate some individuals. Most pools should be super chlorinated once a week.
6. For Super chlorination to be accomplished, one to two ounces of granula chlorine must be added for each 1,000 gallons in your pool.

For Example: A pool holds 24,000 gallons

$$\frac{24,000}{1,000} = 24; 24 \times 2 \text{ ozs.} = 3 \text{ lbs. of chlorine}$$

Sodium hypochlorite in liquid form (8%) can also be used for super chlorination at a rate of one to two cups per 1,000 gallons.

7. Super chlorination with these chemicals will cause the pH to heat up quickly. Wherefore, add a sufficient quantity of acid one hour before super chlorination to keep the pH from getting too high. (Chlorine works best at a low pH.)
8. After the pH has been adjusted, dissolve the correct amount of chlorine in a large clean pail of water in a well ventilated area. There should be a least one gallon of water for every pound of chlorine that you add to the pail. Stir the solution and let it settle. Pour only the clear liquid portion of the solution in equal amounts all the way around the pool perimeter. The residue in the bottom of the pail can be re-diluted, stirred, and the clear portion added to the pool. The remaining undissolvable residue should be flushed down a drain to the sewer as it might cloud the pool water.
9. Gas chlorine can be used for super chlorination. However, it may take several hours for the chlorine level to buildup to the point where super chlorination can take place. For example, it would take at least seven hours to super chlorinate (to 10.0 ppm) a 100,000 gallon pool with chlorine from a gas cylinder. After super chlorination with gas chlorine, soda ash must be added to bring the pH back up to normal.

#### 10. Free Chlorine Residual:

Spa pools are required by state regulation to maintain a minimum free chlorine residual of 1.5 ppm when in use. The cabinet requires operators to maintain a 1.5 to 3.0 ppm free chlorine residual.

#### Chloramines:

The bad odors (foul locker room smell) associated with spa pools are quite often caused by excessive combined chlorine (chloramines) levels. These chloramines are produced by chlorine combining chemically with perspiration, body oils, urine, etc. Combined chlorine is calculated in the following way.

Total chlorine minus free chlorine equals combined chlorine.

The maximum allowable level of combined chlorine is 0.2 ppm. To eliminate this combined chlorine it is necessary to super chlorinate—to raise the free residual by 5-10 ppm. How much chlorine it is necessary to add depends upon how much combined chlorine is present.

Super chlorinating must be done only when the pool is unoccupied.

#### Super chlorinating (Shock treating):

To eliminate excess chloramines (above .2 ppm) it is necessary to add extra chlorine to “burn out” the combined chlorine. This is called super chlorination. How much chlorine it is necessary to add depends upon the amount of combined chlorine which is present. As a starting point for a 1000 gallon spa pool, add one cup of liquid chlorine or two (2) ozs of granular chlorine pre-mixed with one gallon of water. A more exact approach to shock treating is available from your Health Department inspector. Remember a spa pool will probably need to be super chlorinated daily.

Some tips to remember when SHOCK TREATING:

\*CLOSE THE POOL

\*SHOCK TREAT when chloramines exceed .2 ppm.

Turn up chlorinator or hand feed.

Note: This is the only time that hand feeling is allowed.

\*Lower pH to around 6.9 before adding chlorine.

\*Pre-mix granular chlorine with water in advance and don't put sediment into the pool.

\*Measure the free chlorine levels the next morning BEFORE anyone gets in the pool.  
\*If the free chlorine reading is above 3.0 ppm use less chlorine the next time you super chlorinate.

\*If the free chlorine reading is zero, use more chlorine the next time you super chlorinate.

\*Contact your Health Department inspector for assistance.

\*When testing the chlorine residual, don't use your finger to cap the test kit tube when shaking the mix.

\*High chlorine levels may bleach out the color of the DPD and give false reading to zero chlorine. Keep some paper test strips on hand to check for excessive chlorine.

\*FOLLOW THE DIRECTIONS OF YOUR KIT AND USE FRESH REAGENTS DESIGNED FOR YOUR KIT.

pH is a measure of how acidic or basic the spa water is. A pH value less than 7.0 indicates acidic water, whereas a value greater than 7.0 would be basic. The acceptable pH range is from 7.2-7.8 The following table summarizes problems created by water which is not within the acceptable range:

Too High	Too Low
*Lower Chlorine efficiency	*Rapid dissipation of chlorine
*Scale formation	*Plaster/concrete etching
*Cloudy water	*Eye discomfort
*Increased chemical demand	*Corrosion of metals
*Eye discomfort	

pH CHEMISTRY:

1. pH can be thought of as the proportion of acid constituents to base constituents.
  - a. If water has more acid constituents than base constituents, it is considered to have an acid or low pH.
  - b. If water has more base constituents than acid constituents, it is considered to have a base or high pH.

An example of a strong acid is hydrochloric acid; an example of a strong base is a drain cleaner.

2. Obviously, for the protection of swimmers, pool water can be neither strongly acid nor strongly base. Rather, the amount of acid constituents should almost equal the number of base constituents. The recommended pH range for swimming pool water is 7.4-7.6, a range of 7.2 to 7.8 is required. It is important to maintain pH around 7.4 because chlorine disinfection power is good, the eyes are more comfortable at this pH and the water is not as corrosive.
3. If the pH is low (below 7.2) the following conditions are more likely to occur:
  - a. Rapid loss of chlorine from the pool.
  - b. Eye irritation.
  - c. Corrosion of metal pipes and equipment.
  - d. Etching of the pool interior finish.
4. If the pH is too high (above 7.8) the following conditions are more likely to occur:
  - a. Rapid loss of chlorine from the pool.
  - b. Eye and skin irritation.
  - c. Scale formation in pipes and equipment.
  - d. Cloudy water.
5. Almost every thing added to the pool water including dirt, perspiration, suntan lotion, and even fresh water will have an effect on the pH. But it is the use of chlorine products that has the greatest impact on pH.
  - a. If your pool uses solution chlorine (HTH, Sentry, or liquid bleach), the pH will tend to rise from day to day because this kind of chlorine adds more base constituents to the water.
  - b. If your pool uses gas chlorine, the pH will drop rather quickly because gas chlorine adds more acid constituents to the water.
6. When the pH starts to go out of the recommended range it can easily be corrected by the addition of the correct pH control chemical.
  - a. To raise pH, add more base to the pool (increase base constituents). Add soda ash (sodium carbonate).
  - b. To lower pH, add more acid to the pool (increase acid constituents). Add dry acid (sodium bisulfate) or muriatic acid.

7. When adding these chemicals, add small amounts at a time, never over two pounds of chemical per 10,000 gallons of pool water. Wait an hour, test the pH, and add more chemical if necessary. Fill a large clean plastic bucket with water, add the chemical, stir, and pour the dissolved solution in equal amounts all the way around the pool perimeter. No one should use the pool during or within an hour of adding a batch of these chemicals. Use caution; these chemicals are severely irritating to the skin and eyes.

pH:

The ability of chlorine to disinfect water is greatly influenced by the pH of the water. The following table illustrates the effect pH has on the amount of germ fighting chlorine available.

pH	% Germ Fighting Free Chlorine
6.5	90
7.0	73
7.2	66
7.6	45
8.0	21
8.5	10

You can see that pH has a very dramatic effect on the ability of chlorine to perform its work of disinfecting pool water. It is for this reason that pools are required to do a pH test along with a free chlorine test.

Follow the directions of your test kit to determine pH. The test will consist of adding phenol red indicator—tablet or drops—to the water and comparing the resulting color to a standard.

#### CHLORINE AND pH TESTING:

Improper water quality is the most frequent reason for pools being closed. Testing for free chlorine must be done daily. The Health Department requires a minimum of three (3) tests each day for both free chlorine and pH and one daily test for combined chlorine. The results of water tests must be recorded on log sheets. DPD test kits are the only approved type. The old OTO kits do not accurately distinguish between free and combined chlorine. OTO kits are not acceptable.

Spa pools should be tested by the operator before anyone is allowed to enter the water. If the spa pool has a heavy bather load, water testing should be done many times each day to assure that proper water disinfection is taking place. The high temperature of the spa water environment causes rapid depletion of the chlorine residual. More frequent water testing is necessary because of the many factors which

interfere with disinfection in the spa pool: heavy bather load, water agitation and high water.

Tips to remember when testing for free chlorine:

\*Don't collect the test samples near an inlet. The inlets are returning freshly chlorinated water to the spa and would not provide a representative sample of the spa water.

\*Take the samples eighteen (18) inches below the surface.

\*Read the free chlorine results within one minute.

\*Rinse the test tube well or your reading may not be accurate.

1. A test kit is essential for the operation of a swimming pool because it is the simplest way pH and chlorine levels can be determined. The water should be tested as often as necessary to assure that correct levels are maintained. However, the chlorine test must be performed and recorded on the log sheet at least three times a day. The first test of pool water for pH, free chlorine, and combined chlorine should be before the pool opens.
2. Accuracy with some operator's test kits has been a problem in the past years. You are encouraged to compare your kits performance with the standardized kits of the Health Department whenever an inspection is made. To reduce the possibility of error, the following recommendations are made.
  - a. Replace the test chemicals each season with only the brand made for your kit
  - b. Keep the test kit dry and out of direct sunlight.
  - c. Operators should take care in storing liquid chemicals to prevent freezing and overheating.
  - d. Collect the test samples several inches below the pool surface, away from an inlet.
  - e. Carefully follow the directions provided with your kit and read the result as quickly as possible after adding the test chemical.
  - f. If chlorine test shows that chlorine levels are high in one end of the pool and low in the other the problem is bad inlet adjustment.
3. Essentially all test kits use phenol red for the determination of pH. However, there are two common methods of chlorine measurement.

The DPD method is more accurate of the two and turns pink in the presence of chlorine. One part of this test tells you how much free chlorine. One part of this

test tells you how much free chlorine (the germ killer) you have and the other part tells you how much combined chlorine (the eye burning kind) you have. The DPD method is used and required by the Health Department.

The other type is the OT (orthotolidine) method which turns yellow in the presence of chlorine. The results of this method are often misleading because the test measures the free and the combined chlorine together and there is no way to know how much of each kind you have.

#### ALKALINITY:

Alkalinity is an important characteristic of water to be considered by the operator because of its effect on pH. Alkalinity is a measure of the ability of the water to resist pH changes. Another way to say this is the amount of buffer in the form of carbonate found in the water. Many test kits already used by spa operators have the capability of measuring alkalinity. A total alkalinity of 100 ppm is ideal. For example, Lexington's public water supply frequently has an alkalinity of 60 ppm so that an adjustment may be needed. This low alkalinity water will tend to eat away at pool interior surfaces and the pH level will be very difficult to maintain. You may find the pH "bouncing" if alkalinity is not adjusted.

To raise alkalinity, baking soda (sodium bicarbonate) is added at the rate prescribed on the package (if purchases from a pool supply company). The following table may be useful:

#### TO INCREASE TOTAL ALKALINITY WITH BICARBONATE OF SODA (BAKING SODA)

	Gallons	
Ppm	500	1000
10	2 ½ tablespoons	1/3 cup
20	5 tablespoons	½ cup
50	¾ cup	1 ½ cups
70	1 cup	2 cups

One and one-half (1 ½) pounds of sodium bicarbonate per 10,000 gallons will raise alkalinity by 10 ppm.

#### V. SAFETY:

##### SAFETY PRACTICES:

1. The gate to the pool enclosure must be locked whenever the pool is not open for swimming. This includes the winter months, at night, and during the day when the pool water is not up to par or is being treated with chemicals.
2. As the certified operator of your pool, you are responsible for closing your pool whenever problems arise that could affect the health or safety of those using the pool. Such problems include, but are not limited to equipment problems, (inoperative chlorinator, pump, filter), cloudy water, improper chlorine and pH levels, and safety hazards. Your operator's certificate may be revoked if any of these problems are found and you have not locked the pool gate. A certified pool operator cannot reopen an officially closed pool. Only the Health Department can reopen an officially closed pool.
3. The following is a list of other safety rules that you should be aware of.
  - a. A child less than 16 years of age may not use the pool without an adult in attendance who is willing to assume responsibility for that child.
  - b. Food and drink are not allowed within the pool area because of the associated problems with broken glass, litter, and spillage.
  - c. Life saving equipment consisting of a ring buoy with attached rope, a shepherd's crook mounted on a 12 foot minimum pole, and a spineboard must be readily available on the deck to aid in rescues.
  - d. Depth markings and various warning signs must be prominently displayed.
  - e. A well-stocked first aid kit must be available to pool users.
  - f. The emergency rescue number, 911 or other suitable emergency numbers, must be posted at a nearby phone.
  - g. Electricity and water can be a dangerous combination. Do not allow the use of plug-in radios and other appliances around the pool. Promptly repair damage to electrical fixtures such as underwater lights and junction boxes.

A checklist of some safety related items are given below:

\*Shepherds crook and ring buoy with attached rope readily access

\*Step edge with contrasting stripe

\*Safety line across pool at depth change

\*Depth marker, horizontal and vertical

\*Lifeguard or "Warning, No Lifeguard on Duty" sign

\*\*"Children Should Not Use Pool Without An Adult in Attendance" sign

- \*Children adequately supervised
- \*"No Diving" sign (pools less than 8.5 feet deep only)
- \*Therapeutic pool rules sign; water temperature (104 F Max)
- \*Emergency telephone number posted at nearby phone

#### Hyperthermia:

The high water temperatures of spas, hot tubs, and therapy pools can elevate human body temperatures to above normal limits. Hyperthermia causes drowsiness; a number of bathers have fallen asleep in the spa, slid underneath the water, and drowned. When alcohol consumption or use of certain medications is added, the potential for sleepiness is significantly increased.

#### Alcoholic Beverages:

Despite the popular image of people in spa pools drinking wine or other alcoholic beverages, do not use alcoholic beverages before or during spa use. Alcohol is a depressant which causes slowed reflexes and drowsiness, especially in conjunction with the relaxed soaking in hot water. This can lead to sleep or unconsciousness and possibly result in drowning.

Going to a spa with other people is not a preventive measure if they are also drinking and likely to become similarly affected by the combination of alcohol and soaking in hot water. Deaths have occurred from this kind of situation. The spa industry has also taken a strong position against mixing spas and alcohol.

Whenever you have beverages around your spa pools, do not use glass or other breakable containers.

#### Water temperature; Hotter is not better:

The water of your hot tub should not be warmer than 104 F. Always keep an accurate thermometer in the tub water because your spa's thermostat may be in error. Use a high quality shatterproof thermometer with at least one degree increments.

Water which is too hot can raise the body temperature high enough to cause heat stroke (the body's inability to regulate its internal temperature). This can be fatal even to healthy adults. If you have any questions about your own fitness or ability to soak in a spa, you should check with your physician.

A temperature of 100 F. is considered safe and comfortable for a healthy adult. Most healthy adults can enjoy this water temperature for as long as desired, although it may raise the body temperature to the water temperature, and eventually become uncomfortable (like a fever). Generally bather (s) should limit their stay to 15 minutes at a time. If you are planning a long rest in the tub, lower the water temperature closer to normal body temperatures useful as an energizing experience. Try different water temperatures in the 98 – 102 F. range until you find what suits you best.

The Surrounding air temperatures will also affect the way your spa's water feels, especially for outdoor spas. On hot or cold days, the hot tub water may seem warmer or cooler than it really is. Therefore, always check your thermometer for the true water temperature before adjusting your water heater. The point is that you should not rely on your estimate of the water temperature because you may inadvertently raise the temperature too high for safety.

Special caution is recommended for young children; their temperature rises faster than an adult's. Children's small bodies cannot absorb much heat, and their sweat glands are not fully developed.

Pregnant women should be careful to limit their spa soaks to ten (10) – fifteen (15) minutes at a maximum water temperature of 102 F. Longer soaks can raise the body temperature high enough to cause fetal damage, particularly during the first three (3) months of pregnancy (possible resulting in a child with brain damage or deformity). Women in their child-bearing ages may want to note this precaution in the event they may be pregnant and not know it.

One way to prevent overheating is to not submerge your entire body in the spa water. Keeping your arms and shoulders out of the water is a good way to keep from getting too hot.

#### Health Conditions and Medications:

Soaking in hot water causes changes in the circulatory system, such as enlargement of blood vessels near the skin. Therefore, people with a medical history of heart disease, circulatory problems, diabetes, or blood pressure problems should check with their physician before using spas. Additionally, people taking medications causing drowsiness, such as tranquilizers, narcotics, antihistamines or anticoagulants should not use spas without asking their physician, due to the risk of drowning described in the previous section. Any drugs and substances which may affect your judgment, or cause drowsiness or sluggishness, should also be avoided for the same reason.

#### AIR SYSTEMS:

There are two (2) types of air bubble systems in spas and some may have both types. The first type has an air blower that blows air through holes in the bottom and seats of the spa and sometimes into the water jets.

The second type has no air blower but air is inducted into high pressure water jets powered by separate water pumps. These separate water pumps can create high suction levels at the drain grates in the bottom of the pool.

#### Timer Controls:

In an effort to control problems caused by hyperthermia, spa pools should have a two-pump system. One pump operates the recirculation system, and the second pump

operates the hydrotherapy jets. A fifteen (15) minute timer switch connected to the hydrotherapy pump and air blower (if provided) reminds the bather to exit the spa. By leaving the spa to reset the timer, the bather's central nervous system has the opportunity to warn him or her of the energy-sapping effect of the hot water. Also, the fifteen (15) minute timer gives a pregnant woman notice to exit the spa.

All spa electrical equipment should be wired according to the National Electric Code and all relevant local codes under city, county, or state permit. Such work should be inspected by the local jurisdiction for your protection (safety and liability). All outlets must be GFCI (ground fault circuit interrupter) Protected to prevent electric shock.

GFI – Ground Fault Interrupter:

If this device is properly installed you have an improved circuit breaker offering protection against overloads, and short circuits, plus protection for people against ground fault electrical currents that can cause loss of life. Ground fault currents are the electrical currents which flow when, for example, a person contacts the "hot" side of a one hundred twenty (120) volt circuit while standing on or contacting an electrical ground such as a water fixture, wet floor, spa pool, or earth.

When the breaker trips, it may indicate an overload in the circuit or it may indicate leakage current caused by faulty insulation or wet wiring inside some appliance or equipment connected to the circuit. Always consult a qualified electrician.

Do not use electrical appliances while using a spa, (e.g. hair dryers, radio, etc.) in order to avoid electric shock.

Body entrapment and hair entanglement:

Over the past few years, cases of bathers being either entrapped on suction fittings or having their hair entangled in them have been reported by various agencies.

To illustrate how this may happen, assume that a spa pool with a ½ h.p. recirculation pump is capable of producing fifteen (15) to twenty (20) pounds of suction per square inch of surface area on the eight (8) inch suction fitting of the spa. This suction fitting has a surface area of approximately fifty (50) square inches. Thus, the pump is capable of exerting seven hundred fifty (750) to one thousand (1,000) pounds of suction. Most individuals do not have sufficient strength to overcome this much pull.

Hair entanglement problems generally occur in spa pools when bathers are misusing the facility (i.e., doing handstands in the spa.) When this occurs, bathers, especially females with long hair, are subject to having the hair pulled through the open grates in the suction fitting. The internal turbulence of the water within the suction fitting can cause the hair to become entangled and trap the bather beneath the surface of the water. IN an effort to resolve these problems, the following recommendations are made:

1. Each pumping system serving a spa pool should have a minimum of two (2) suction orifices. The piping from the suction orifice should be the same pipe diameter, and the system designed so that neither one of the outlets can be cut out of the suction line by a valve or other means.
2. All suction orifices should be equipped with anti-vortex plates.

Children are particularly vulnerable, and they should be warned against this danger. Broken or missing drain covers should be replaced immediately. If your spa has raised drain covers which can snare long hair, make sure long hair is pinned up or at least not flowing loosely. If a child's body is sucked against a flat drain opening whose grate is broken or missing, the child can be freed by shutting off the pump immediately or placing your flattened hand between the child and the drain to break the suction.

Do not allow children to use a hot tub without supervision. Adults should also use caution - as a minimum safety precaution, one person using a tub should have someone within calling distance, check the bather regularly. Ideally, a hot tub should never be used alone.

Slips and falls on wet deck surfaces can also cause injury. Non-slip surfaces, good deck drainage, steps and hand holds are important safety features.

#### WARNING SIGNS:

##### Required Warning Signs:

Where no lifeguard services are provided, or whenever a lifeguard is off duty, a warning sign shall be placed in plain view and shall state "WARNING, no lifeguard on duty," with clearly legible letters. Persons under sixteen (16) years of age shall not use the pool without an adult responsible for the child in attendance. A warning sign shall state "children shall not use pool without an adult in attendance." Pools with maximum depths of less than eight and one half feet ( 8 ½ ) shall not be used for diving and shall have a sign stating "NO DIVING" in clearly legible letters four (4) inches high in plain view. The following precaution sign shall be mounted in plain view adjacent to a therapeutic pool facility in which the water temperatures exceeds 84 F.

#### CAUTION

1. Elderly persons and those suffering from heart disease, diabetes, high or low blood pressure should not enter the pool.
2. Unsupervised use by children is prohibited.
3. Do not use while under the influence of alcohol, anticoagulants, antihistamines, vasoconstrictors, vasodilator, stimulants, hypnotics, narcotics or tranquilizers.
4. Do not use alone.

5. Observe a reasonable time limit, then shower, cool down and, if you wish, return for another brief stay. Long exposure may result in nausea, dizziness or fainting.

A telephone shall be easily accessible to the pool facility with emergency numbers including the rescue squad and the police posted nearby.

Suggested Warning Signs:

To educate and inform bathers of potential health problems, install warning signs, 24" X 18" in size with letters at least ½" high, which are visible upon entrance to the pool enclosure, as follows:

#### STOP

All persons are required to take a cleansing shower before entering the spa pool.

#### CAUTION

Pregnant women, elderly persons, and persons suffering from any heart condition or disease, diabetes, or high/low blood pressure should not enter the spa without prior medical consultation and permission from their doctor.

Do not use at water temperatures greater than 140 F.

Do not use alone.

Unsupervised use by children is prohibited.

Enter and exit slowly.

Observe reasonable time limits (that is, 10 to 15 minutes), then leave the water and cool down before returning for another brief stay.

Long exposure may result in nausea, dizziness, fainting, or death.

Keep all breakable objects out of the area.

Shower before entering the spa.

#### CHEMICALS:

Practices and procedures are most effective if checklist and policies are developed. Inherent dangers exist when chemicals are present.

Handling chemicals is a constant job requirement, and good habits are essential for accident prevention. The following is a list of safety rules that should be posted in and around the area of chemical use.

1. FOLLOW INSTRUCTIONS: mix chemicals only in the manner the instructions on the containers say to do.
2. NEVER add water to chemicals; add chemicals to water slowly. PROTECT eyes with glasses or mask while mixing.
3. NEVER mix any chemicals with granular chlorine or liquid chlorine (sodium hypochlorite); a dangerous gas develops immediately.
4. ALWAYS use clean dipper (free of grease, oil, or insecticides) when dipping into a container of granular chlorine; it is a potential fire hazard even though most contain a fire retardant.
5. ALWAYS keep chemicals in their original containers.
6. ALWAYS keep area dry; don't hose down the area.
7. ALWAYS replace chemical containers covers tightly after use.
8. ALWAYS clean up spillage.
9. KEEP chemicals AWAY from electrical equipment and flames.
10. ALWAYS throw empty chemical bags or containers into specifically labeled containers; small quantities can mix with other trash and ignite spontaneously.
11. NEVER FLUSH excessive chemicals into sewers that lead to a septic tank treatment system.

#### ACCIDENT PREVENTION:

Accident prevention is a continuous program that is designed to provide a safe environment for pool patrons. The program includes safety practices and rules, public education, first aid equipment, and training for emergency procedures. A successful accident-prevention program identifies cooperative responsibilities and rules for the entire staff and develops a team attitude among them.

The types of accidents and their potential degrees of severity can be closely identified with specific areas of the pool facility. Slipping and falling, creating abrasions and slight-to-serious head injuries, occur on slippery decks and in areas that require the individual to change direction, such as at corners or around obstacles.

Other than drowning, diving and slide accidents are the most serious. Paralysis, resulting from back or neck injuries, presents the most potential for legal action against pools. Diving or sliding into shallow water, diving into another swimmer, or striking a ledge or protrusion are the main causes for these accidents.

Showers should have preset temperature maximums of 100 F. Boiler and steam areas should have pipes wrapped with insulation, and valves should be easily accessible for shut-off in an emergency.

Electrical accidents can cause serious injuries. The electrical system should have ground fault interrupters (GFI), and installations should follow Article 680 of the latest NATIONAL ELECTRICAL CODE.

Drowning is the third leading cause of death, with approximately seven percent (7%) of them occurring in swimming pools. Drownings can happen under the best conditions. They can happen quickly and unexpectedly. Drownings that can be prevented are those that occur when a person swims without a lifeguard on duty or when swimming alone; when persons present are not trained in CPR or artificial respiration; or when people are not trained to make a nonswimming or elementary form of rescue.

## VI. HINTS FOR PROPER POOL MANAGEMENT

### RECORD KEEPING

The purposes of record keeping are numerous, but they may be categorized. First, Section 12 of the Kentucky Public Swimming and Bathing Facilities Regulation requires pool operators to keep records on forms provided by the Health Department. The forms (log sheets) must be kept daily and made easily available to the Department's inspectors. Repeated violations of this requirement are symptomatic of poor operation, and could result in pools being closed and/or permits suspended.

Secondly, good record keeping can result in better pool operation. It may lead to an organized approach to pool operation, and provides a body of information to refer to when problems arise. Also, it allows evaluation of the system for better overall management. Good record keeping should be the core of a good management plan for any pool.

Finally, good records could be the best protection a pool operator can have if he is sued. In the past, many court cases have been decided in favor of the pool owner or operator when documentation to substantiate correct pool operation was provided by the pool's records and reports.

The records which are required to be kept by pool operators are:

1. The date, time, and results of all water chemistry tests, free chlorine and pH tests (must be performed 3 times a day), and combined chlorine tests (once a day). Alkalinity and cyanuric acid (weekly or more often as needed) should be tested

weekly. More frequent tests should be done during periods of heavy bather loading.

2. The date and time of filter backwashing and cleaning. A regular schedule for these tasks can be developed after sufficient records are accumulated to show the needed frequency.
3. The date that the spa pool was emptied and cleaned. Again, a schedule for these tasks can be developed from the records.
4. The date and amounts of chemicals added to the pool.
5. The dates of malfunctions and repairs, the nature of the problems, and what was required to correct them.
6. Pool bather loads and the times of peak loads.
7. Thermometer readings, along with the times and dates of those readings.
8. The dates of regular maintenance work.

In addition to the required records, it is recommended that pool operators keep accurate records of accidents with all pertinent facts, records of man hours spent on specific tasks, and records of energy demands (gas, electricity) for running the total physical plant. It is also strongly recommended that Health Department inspections be kept on file along with all other related records, correspondence, etc., so that no misunderstandings develop and no delays in making corrections result.

#### CHANGES IN EQUIPMENT:

The Kentucky Public Swimming & Bathing Facilities Regulation, Section 3 (1) requires that "No person shall substantially change, alter, or reconstruct any public swimming pool until plans and specifications have first been submitted in quintuplicate to the cabinet and have been approved in writing." This requirement does not apply to maintenance work or to replacement of equipment with identical equipment. In all case, the Cabinet should be contacted to make a determination on such matters. A telephone call could save the trouble and expense of correcting a situation in which incorrect equipment was installed or the pool structure altered such that the pool is out of compliance.

If for any reason facilities such as the filter, pump, fence, deck fill spout, pipe system, etc., are to be replaced or modified, you are required to tell the cabinet before the change is made. This will help prevent you from being sold the wrong type of equipment and having to make expensive repairs a second time.

#### CLEANING:

1. The pool walls at the water line (usually tile) and the inside of the skimmers will rather quickly accumulate a grease deposit that harbors bacteria and is unsightly. Any detergent based cleaner will remove this deposit but avoid products containing ammonia. Apply the cleaner to a sponge and wipe the tile clean, trying not to get any cleaner in the pool water.

Cleaning the “bathtub ring” that accumulates at the water line removes dirt, oil, and bacteria and improves the sanitation of the spa pool. A strong detergent such as TSP will effectively remove the layer of dirt that forms at the waterline. Every time the spa pool is drained this cleaning procedure should be done. If it is necessary to clean the “bathtub ring” between drainings, care should be taken not to get excessive amounts of detergent into the water or foaming may result.

2. Decks should be swept or hosed off to remove dirt and debris as needed to keep these areas clean. Low wet spots in the deck should be scrubbed to prevent a slick algae growth from developing. A good way to keep algae from growing in the pool water is to maintain at least 1.0 ppm free chlorine.
3. Vacuuming the pool bottom should be done as often as necessary (usually every day) to remove the dirt that accumulates there.
4. Algae is the green microscopic plant that usually appears in the pool as dark spots or patches on the walls and bottoms. Algae will not become a problem if a free chlorine level of 1.0 ppm is consistently maintained. To get rid of an algae problem you should close the pool and super chlorinate. Prior to super chlorination, the appropriate amount of acid should be added if granular chlorine or bleach is used. You may wish to pour the super chlorine solution right on the algae spots. Wait about an hour and scrub all the algae-covered surfaces with a stiff brush mounted on a pole. The Health Department recommends this method over the use of other algaecides.

#### PROPER POOL WATER PARAMETERS:

Chlorine Residual:	1.0 – 1.5 ppm
Cyanuric Acid:	25 – 50 ppm
pH:	7.2 – 7.8
Total Alkalinity:	50 – 180 ppm
Calcium Hardness:	150 – 250 ppm (May be greater than 250 ppm in hard water areas)
Total Dissolved Solids:	Less than 2000 ppm
Copper:	0 - .3 ppm

Iron: 0 - .2 ppm

#### DETERMINATION OF POOL CAPACITY:

Before a pool can be properly treated, the person performing chemical addition must know the pool capacity (in gallons). The following formula will be used for this purpose.

#### Calculation of Average Depth

$$\frac{(\text{Depth at deep end}) + (\text{Depth at shallow end})}{2} = \text{Average Depth}$$

#### Capacity Formulas:

##### Rectangular Pools:

$$(\text{Length}) \times (\text{Width}) \times (\text{Average Depth}) = \text{Capacity (Gallons)}$$
$$\times 7.5$$

##### Circular Pools:

$$\frac{[(\text{Diameter}) \times (\text{Diameter}) \times (\text{Average Depth})]}{5.9} = \text{Capacity (Gallons)}$$

##### Oval shaped Pools:

$$\frac{[(\text{Length}) \times (\text{Width}) \times (\text{Average Depth})]}{5.9} = \text{Capacity (Gallons)}$$

#### Pool Leakage:

To determine the rate of leakage in gallons per hour:

$$\frac{\text{Inches lost} \times \text{surface area} \times .625}{\text{Number of hours}}$$

Example: Water level was marked with a pencil at 8:00 p.m. when the pool was closed. The next morning at 10:00 a.m., before anyone entered the water, the water level had dropped 3 inches. The pool is 75 x 45 feet.

$$\frac{3 \times 75 \times 45 \times .625}{14} = 425 \text{ gallons per hour}$$

#### Makeup Water:

To calculate the amount of water needed to refill the pool after backwashing or as the result of splash-out or evaporation, measure the number of inches required to fill the pool and apply the following formula:

(Inches of water to be added) x (Pool surface area in square feet) x (.625) = gallons of water

Example: 4 inches of water is needed to fill a pool 42' x 75'. So  $4 \times 42 \times 75 \times .625 = 7,875$  gallons.

#### STORAGE, HANDLING:

#### DO NOT STORE OR MIX THE FOLLOWING TYPES OF CHEMICALS WITH CYANURATES

Alcohols (methyl alcohol, ethyl alcohol, rubbing alcohol, etc.)  
Algaecides (quat ammonium chlorides)  
Ammonia (ammonia solutions or gaseous ammonia)  
Ammonium compounds (fertilizers containing ammonia or other ammonium compounds)  
Calcium hypochlorite  
Fungicides  
Glycerin  
Hydrogen peroxide  
Insecticides  
Liquid bleach (sodium hypochlorite solution)  
Oils (penetrating oils, lubricating oil, grease)  
Paint  
Paint solvents (turpentines, linseed oil, toluene, verso, etc.)  
Solvents (gasoline, kerosene, fuel oil, lighter fluid, etc.)

#### HANDLING, SAFETY AND DISPOSAL:

1. Use large volumes of water to dissolve cyanurates completely, then flush to waste.
2. Wash out empty cyanurate containers with water before incinerating or other disposal
3. Follow all local regulations for disposal of hazardous chemicals.
4. Do not permit any solid to enter the sewer.
5. Do not dispose of cyanurates in the same container or area as regular scrap or garbage.
6. Do not attempt to incinerate scrap cyanurates.

7. Do not smoke or eat until dust is thoroughly washed from hands and face.

## VII. GLOSSARY

**ALGAE-** Microscopic aquatic life which grows on pool walls, floors and the surface of the water. Green, blue-green (commonly called black), brown, reddish brown, and yellow organisms known as “mustard algae” are the strains most commonly found in swimming pool water.

**ALKALI-** A term applied to carbonates and hydroxides. Refer to BASE.

**AMPHOTERIC-** A chemical compound with the capacity of serving either as an acid or base, such as sodium bicarbonate.

**BACTERIA-** Microscopic organisms, some of which are disease bearing, which are transmitted into the swimming pool water by bathers, wind, dust, rain, surface drainage, etc.

**BASE-** A chemical which raises the pH when added to swimming pool water. Sodium Carbonate (soda ash) and sodium hydroxide (caustic soda commonly known as lye) are examples of bases.

**BASICITY-** The degree of the alkaline nature of the water.

**BREAKPOINT CHLORINATION-** The amount of chlorine requires to oxidize (remove) ammonia in water.

**BUFFER-** A chemical which when dissolved in swimming pool water will resist pH change. Sodium bicarbonate in this type of chemical.

**CHELATE-** Same as sequester.

**CHLORINE-** A disinfectant added to swimming pool water to destroy and inhibit bacterial and algal growth in addition to oxidizing (burn out) unwanted organic matter. Available in the inorganic form as a gas, liquid and hypochlorite and in the organic form of chlorinated cyanurates.

**CHLORINE DEMAND-** The amount of chlorine required to destroy bacteria, algae and/or other organic matter in water before active chlorine residual can be achieved.

**CHLORAMINES-** An unstable colorless liquid ( $\text{NH}_2\text{C}_1$ ), which a pungent odor. Ammonia generally introduced into swimming water as waste material from the body of the bather, which combines with chlorine forming chloramines, greatly reduces the disinfecting power of chlorine.

**FREE ACTIVE or FREE AVAILABLE or FREE RESIDUAL CHLORINE-** Chlorine that is not combined, i.e., Hypochlorous Acid (HOCl) readily available for rapidly killing bacteria and algae.

**COMBINED CHLORINE-** The amount of chlorine and ammonia combined to form chloramines.

**TOTALLY AVAILABLE CHLORINE-** The combined amount of free active chlorine and chloramines in the pool water.

**HYDROCHLORIC ACID (HCl)-** Commonly called muriatic acid, produced when chlorine gas is combined with water.

**HYPOCHLOROUS ACID (HOCl)-** An unstable, weak acid, existing only in solution and having strong bleaching and disinfectant characteristics. Essential in maintaining Free Active Chlorine in swimming pool water.

**LIQUID CHLORINE-** In swimming pool terminology, sodium hypochlorite (NaOCl) solutions are known as liquid chlorine.

**ODORS-** Usually the result of chloramines or sulfur in water.

**pH-** The measurement of relative acidity and basicity in swimming pool water. The pH range is from 0 to 14. A pH value of 7 is neutral. pH values below 7 are acidic and values higher than pH 7 are basic.

**PPM-** Parts per million. The rating of a quantity of any substance per million parts of water.

**RESIDUAL CHLORINE-** The chlorine remaining in the water in a free state after the chlorine demand of the water has been satisfied.

**SCALE-** The mineral deposits or precipitants, usually calcium carbonate caused by hard water, on the floors, walls, metal piping, filter system, etc., and can become unsightly and may interfere with the proper operation of the pool.

**SEQUESTER or CHELATE-** Addition of specially formulated compounds to tie up iron, copper, or calcium carbonates to prevent staining or scaling.

**SHOCK TREATMENT-** See Super Chlorination

**SODIUM BICARBONATE- (NaHCO<sub>3</sub>).** Baking soda. Very effective in alkalinity control. The pH and point is 8.2. However, sodium bicarbonate is hygroscopic and this can pick up moisture generally found around swimming pools.

When this occurs the material has a tendency to become lumpy and convert to the sesqui carbonate state, thereby raising the pH end point to 8.3 or 8.4. Sodium

bicarbonate increases the alkalinity rapidly and the pH much less rapidly. The pH of the water will not rise above 8.2 to 8.4 even though larger additions than required are made through error.

SODIUM BISULFATE- A dry acid used to reduction of pH and/or alkalinity in swimming pool water. It should be introduced in proper quantities as determined by acid demand titration.

SOFTEN- The removal of calcium and magnesium.

STABILIZER- Addition of cyanuric acid to screen the chlorine of the water against loss due to the ultra-violet rays of sun.

SUPER CHLORINATION- A process in which excess chlorine generally in amounts of 10 ppm is added to the pool water to remove ammoniacal and proteinaceous nitrogen from pool water.

TITRATION- A method of testing for total alkalinity, hardness, etc. Also for making determinations as to the amount of acid which may be safely added to lower pH.

TOTAL ALKALINITY- A measurement of the total amount of alkaline (base) chemicals in pool water.

VIRUS- Submicroscopic infective agents capable of growth and multiplication only in living cells and that cause various important diseases in man.

WATER HARDNESS- Refers to the amount of dissolved solids in the form of mineral salts, such as calcium and magnesium, in the water which can readily precipitate with some organic matter such as soaps, etc. Water hardness is usually expressed as the calcium carbonates, (CaCO<sub>3</sub>) content of water.