The Portsmouth Health Department's Pool Operation And Maintenance Guide

Compiled and edited in 2018

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Chapter 1

Pool Construction

Construction of Public Swimming Pools

Basic Considerations

Pool construction standards are governed by the Building Officials and Code Administrators, International Code (Boca Code). This code represents national standards of construction areas such as building materials, plumbing, electrical and mechanical equipment and installation and is adopted by reference by the Commonwealth of Virginia and local governments.

The current addition of the Portsmouth City Pool Code requirements has not been revised in a number of years. Consequently, some of the requirements do not parallel current industry standards. The swimming pool industry should be commended for exceeding the minimum standards required by BOCA and the Portsmouth Health Dept.

This chapter is broken down into several categories of construction and related equipment and installation for the convenience of the readers.

Design

Location - The location of the swimming pool shall in no way hinder the operation for which it is designed nor adversely affect patron safety or water quality.

Shape – Pools may be of any dimension or shape provided that the satisfactory recirculation of water can be obtained and undue hazards to bathers are absent.

Access – Direct and unobstructed access to the pool area should be provided for the admission of emergency or service vehicles, equipment or personnel.

Structural – The pool structure shall be engineered and designed to withstand the expected forces to which the pool will be subjected.

Materials – Swimming and wading pools should be constructed of materials which are rigid, inert, impervious and non-toxic to man, which will provide a tight tank with a smooth, easily cleaned surface; or to which a smooth and easily cleaned surface must be applied. This surface must consist of an impervious material which will retain a smooth finish with no cracks or open joints and which will provide a non-slip footing for swimmers. All corners shall be coved. Sand or earth bottoms should not be permitted in construction. Materials other than those described above may be considered and accepted by the Portsmouth Health Dept.

Slopes – Walls shall not slope more than one unit horizontal in five units vertical. The slope of the floor on the shallow side of the transition point shall not exceed one unit vertical to seven units horizontal. For public pools greater than 1,200 sq. ft. the slope of the floor on the shallow side of the transition point shall not exceed one unit vertical to ten units horizontal. The transition point between shallow and deep water shall not be more than five feet deep.

Hydrostatic Relief Valve – On all in-ground swimming pools, one or more hydrostatic relief valves should be installed for the purpose of relieving the groundwater pressure on the pool shell.

Sanitary Construction

Water supply – All swimming pools shall be provided with a potable water supply, free of cross connections with the pool or its equipment. The chemicals and physical properties of pool water should be the same as drinking water with low turbidity, neutral pH and the absence of harmful organisms or chemicals. Well supplies must be protected from surface contamination. Fresh make up water must be introduced through an air gap or vacuum breaking devices to protect against back siphonage.

Decks – All public pools shall have walkways not less than 4 feet in width extending entirely around the pool. Curbs and sidewalks around any pool shall have a slip resistant surface for a width of not less than one foot at the edge of the pool, and shall be so arranged as to prevent return of surface water to the pool.

It is preferable to extend the deck to 8 to 10 feet around the pool. The deck should slope away from the pool ¼ inch per foot and be provided with one floor drain per 100 square feet of surface area.

Depth markings visible both during the day and under artificial light should be placed at regular intervals at the pool periphery and spaced not more than 20 foot increments. It is recommended that depth markings be placed both on the deck and at the water surface on the side walls.

Steps and ladders – Public pools shall provide ladders or other means of egress at both sides of the diving section and at least one means of egress at the shallow section; or at least one means of egress in the deep section and the shallow section if diving boards are not provided. Treads of steps and ladders shall have slip resistant surfaces and handrails on both sides, except that handrails are not required where there are not more than four steps and /or where steps extend the full width of the side or end of the pool. When built-in steps are constructed, they should not protrude into the pool but, should be recessed and provided with one or more handrails.

Fencing – Public swimming pools shall be provided with an enclosure surrounding the pool area. The enclosure shall extend not less than 4 feet above the ground. All gates are recommended to be self-closing and self –latching with latches placed at least 4 feet above the ground.

Enclosure fences shall be constructed so as to prohibit the passage of a sphere larger than 4 inches in diameter through any opening. The gap at the base of the fence should not exceed 2 inches. Fences shall be designed to be durable.

Chapter 2

Recirculation and Filtration

Recirculation and Filtration

Please note that the diagram Figures 2 (A thru N) are located in Attachment 1.

The Recirculation System

All modern swimming pools/spas use recirculation systems. They use a pump to circulate water through a series of pipes in order to pass it through a filter, provide thorough disinfection, balance the temperature, and eliminate any areas where bacteria, debris, or other foreign matter can collect. Careful designing for proper sizing of components is necessary to ensure water quality and conservation of water.

The recirculation system of a swimming pool/spa operates much like the human body's circulation system where the heart distributes blood to the blood vessels. The pump is the "heart" of a swimming pool/spa. It keeps the water constantly moving or "circulating" from out of the pool through the recirculation system, then back into the pool.

Figure 2(A) diagrams a schematic of a typical recirculation system. Water is drawn by the pump through the main drain at the bottom as well as from the surface through skimmers or gutters. The water then passes into the pump through a strainer, which removes large debris. (The water passing into any equipment before entering the pump is called **influent** water and is said to be on the suction side of the pump. The water passing out of the pump is called **effluent** water and is said to be on the discharge or return side of the pump). The water then passes through a filter where dirt particles and impurities are removed - physically cleaning the water. The water may then be heated and finally chemically treated before returning through return inlets. One type of chemical treatment should include a disinfectant to biologically clean the water.

Water Flow Pattern

There are four water flow processes which may occur during normal operation of the recirculation system. These processes are essential to the maintenance of the pool water quality and maximization of disinfection efforts. These water flow processes are filtration, vacuum cleaning, backwashing, and pool filling.

Filtration – Filtration is defined as the act of removing bacteria, viruses and suspended matter from a liquid or gas by passing the liquid or gas through a porous substance (filter). This process occurs when the recirculation system is in operation and usually defines the system.

Vacuum cleaning – The purpose of vacuum cleaning is to remove large debris from the pool sides and bottom and provide a clean looking appearance. The pipes leading from the main drain and skimmers or gutters are throttled down or shut off, and the pipe from the vacuum fitting is opened permitting the pump to pull through this pipe. The vacuum cleaner is attached to the vacuum fitting, which then removes dirt from the pool and carries it to the filters along with the pool water. The vacuum cleaner relies on the vacuum action of the suction side of the piping to accomplish this cleaning. If a vacuum fitting is not

available, the vacuum cleaner may be attached to a suction valve in the skimmer or to a wall suction outlet. Manual or self propelled vacuum equipment can be used.

Backwashing – During the backwashing process, pool water is withdrawn from the pool as it is for the normal filtering operation, but the flow is reversed through the filter and the accumulated dirt is forced out of the sand and discarded (See figure 2 C). Pools with diatomaceous earth filters use a different backwash procedure. However, since very few pools are currently using these type of filters, the procedure will be discussed in the chapter on alternative filtration systems.

Pool filling – Pool water lost through drainage, evaporation, backwashing, splashing, or other means of depletion can be added in two (2) ways:

- Pool water is added through a fill spout or hose from a fresh water supply
- Pool water is added through a makeup tank

Flow Distribution and Dead Spots

Proper positioning of the pipe outlets and inlets is extremely important to provide uniform movement of the filtered water into the pool. The water flow should cover the maximum distance possible from outlet to inlet providing equal dispersion throughout the entire pool area. If this cannot be accomplished, short circuiting of the filtered water is likely to occur and dead spots may develop. Dead spots are a problem because the water is not properly disinfected which may promote growth of bacteria and algae and may require more frequent cleaning.

A simple method for identifying dead spots is to check the disinfectant residual level at various locations in the pool and note where the level is significantly lower than the average. If dead spots are found, increase the overall disinfectant level to maintain adequate disinfection.

Dead spots can be reduced if the pool/spa has floor inlets which are adjustable for variable gallons per minute flow. In the case of small pools/spas where the inlets are in the side of the pool, the use of adjustable, directional flow valves can reduce problems of poor circulation.

Turnover Rate

An adequate turnover rate is necessary to ensure a safe, sanitary pool operation. The turnover rate of a recirculation system is the amount of time it takes to move the water from the pool/spa outlets through the recirculation system and return it back through the inlets. A well designed and balanced system will maintain adequate pressure through the filter and provide a desirable turnover rate. Turnover rate is generally measured in hours. The recommended turnover rates to provide efficient disinfection and maintain pool water clarity are as follows:

- Public pool 6 hours
- Semi-public pool 8-12 hours
- Wading pool 2 hours
- Spa 30 minutes

The formula for determining the actual turnover rate for a swimming pool is:

$$\text{Hours} = \frac{\text{Pool volume in gallons}}{\text{Reading from flow meter (gpm)} \times 60 \text{ minutes}}$$ **(Figure 2 D)**

If the actual turnover rate is found to exceed the hours recommended, you should calculate the rate of water flow needed to provide the desired turnover rate. Flow rate is measured in gallons per minute (gpm). The formula for calculating the necessary flow rate for a swimming pool is:

$$\text{Flow rate} = \frac{\text{Pool volume in gallons}}{\text{Recommended turnover rate (hrs)} \times 60 \text{ minutes}}$$ **(Figure 2 E)**

These formulas are used to determine how effectively your recirculation system is operating. For example, if a public swimming pool has a volume of 36,000 gallons and the flow meter is reading 60 gpm, is the pool operating optimally? If not, what rate of flow is necessary to correct the problem?

SOLUTION:

$$\text{Hours} = \frac{36{,}000 \text{ gallons}}{60 \text{ gpm} \times 60 \text{ minutes}} = \frac{36{,}000}{3{,}600} = 10 \text{ turnover rate}$$

Therefore at a 10 hour turnover rate, the public swimming pool is not working optimally since the recommended rate is 6 hours. To determine the rate of flow necessary to correct the problem, the following calculations must be performed:

$$\text{Flow rate (gpm)} = \frac{36{,}000 \text{ gallons}}{6 \text{ hr turnover rate} \times 60 \text{ min.}} = \frac{36{,}000 \text{ gal.}}{360 \text{ min.}} = 100 \text{ gal/min.}$$

In this example the system should filter 100 gallons per minute to obtain the recommended 6 hour turnover rate.

The flow meter is the key to assessing the overall operation of the recirculation system and maintaining an adequate turnover rate. By visually checking the flow meter on a regular basis you can assess the system and take the necessary measures to ensure a safe and sanitary pool/spa. The flow meter is your guide to the well-being of your system.

Basic Piping and Equipment In The Recirculation System **(Figure 2 B)**

Piping should be selected on a basis of flow rate needed to carry the necessary turnover of the pool/spa water without producing excessive pipe velocities. Connections need to be tight fitting and intact. Poor fitting promote leakage which requires excessive makeup water or will allow air to get into the lines and cause problems with the pumps.

Pipes should be designed for a velocity of 4 to 8 ft/sec or less. To calculate the velocity a rule of thumb to use is:

$D^2 \times 10 =$ gpm at 4 ft/sec (D^2 = diameter squared)

What is the pipe velocity for example of a 6 inch pipe handling a 50 hp pump at 500 gpm?

$$6^2 \times 10 = 360 \text{ gpm at 4 ft/sec.}$$

$$\text{At 500 gpm: } \frac{500}{360} = \frac{X}{4} \quad \text{where } X = \frac{2000}{360} \quad X = 5.5 \text{ ft/ sec. in a 6 inch pipe}$$

A pipe velocity of 5.5 ft/sec in a 6 inch pipe would be within the recommended parameters.

Like the piping, the equipment should be sized to facilitate the desired turnover rate.

I. OUTLETS - The outlets simply release or exit water to the recirculation system. There are two locations (outlets) that water is drawn from the pool/spa for filtration and disinfection: the main drain and the skimmers or gutters.

A. Main Drain: The main drain draws water from the bottom of the pool/spa and removes particles that are heavier than water. The position of the main drain determines the pattern of water flow since water entering the multiple inlets at the perimeter is drawn down to the main drain. To help this water flow pattern, the main drain should always be located at the deepest end of the pool/spa. The number of main drains should be increased if the pool width exceeds 20 ft.

The grate covering the main drain should be visible and meet the requirements of the *Virginia Graham Baker Pool & Spa Safety Act.*

The main drain also serves as an outlet for draining the pool.

B. Skimmers or Gutters: Skimmers or gutters draw water from the surface of the pool/spa and remove contaminants such as body oils, perspirations, algae, leaves, and insects. The surface water contains the majority of contaminants which may infiltrate the water so it is important that this water is circulated for filtering and disinfecting.

Skimmers are usually found on private or semi-public pools instead of gutters. (**Figure 2 G**) illustrates a cross-section of a typical surface skimmer. Being just below the water surface, it is capable of re-circulating a large volume of water. The weir (a) adjusts the water level over a 3-4 foot range and controls the flow into the body of the skimmer. The skimmer works on the basis of the pump action lowering the water level (b) behind the floating weir (a). The floating weir controls the skimming action with the water level. This action helps to ensure that a consistent quality of water can be re-circulated through each of the skimmers. The debris is caught in the basket strainer (c) inside the skimmer. The strainer acts to protect the pump. It should be cleaned out daily to allow for maximum flow through the skimmer.

The weir also breaks the water surface tension to allow the floating debris to be sucked to the strainer (c), the hair catcher, or the filter. Some skimmers may have, instead of a weir, a float in the basket strainer. The weir or float is essential to facilitate this action. Without the weir or float there may be a loss of 30-50% in efficiency of filtration.

If the water level goes down below the level of the skimmer inlet or the strainer basket clogs, the float valve assembly (e) will drop, sealing the upper area of the skimmer body. The flow is then diverted to the equalizer line (d) which is located below the weir inlet. This assures an alternate passage for water to

come into the system to prevent a partial vacuum developing in the pump or excessive suction from the main drain.

There are several installation requirements when skimmers are used:

- At least one skimmer should be provided for each 600 sq. feet of pool surface.
- Each skimmer should have a flow-through rate of at least 30 gal/min. and all skimmers should be capable of handling 80% of the required filter flow of the re-circulation system.
- The equalizer line should be at least a 2 inch line. It should be installed at least one foot below the overflow level of the skimmer.

Overflow or scum gutters may be installed instead of skimmers. Usually they are found around the perimeter of the pool. There are many types of gutters (**Figure 2 H**). The open gutter is usually the best design.

Installation requirements for overflow gutters are:

- Overflow gutters should be installed at a uniform level and continuously around the pool.
- There should be a minimum depth of 2-3 inches from the top to the bottom of the gutter to provide a handhold for the bather
- Gutter drains of at least 2½ inches in diameter should be located on 10-15 feet centers in the trench bottom. This is to reduce clogging.

II. BALANCING OR MAKEUP TANK – The water being drawn from pools equipped with gutters may be replenished using a balancing or makeup tank. This tank is connected to the suction side of the pump and maintains a constant level of water in the pool. Water lost through backwashing, evaporation and splash is replaced as needed through a fresh water connection which is controlled by a float valve. The makeup tank can also be used to introduce chemicals in an emergency situation. This tank is not required for small pools where the floating weirs in the skimmers control the fluctuations in the water level.

Installation requirements for a makeup tank:

- The fresh water inlet must be protected from back siphonage using an air gap or an approved backflow preventer.
- A waste fitting should be installed to provide a path for overflow water from the tank in the event the float does not operate properly. The fitting should not be connected directly to a sewer.

III. HAIR AND LINT CATCHER OR HAIR STRAINER – The hair and lint catcher, located between the pool outlets and the suction side of the pump, protects the pump from clogging or being damaged by hair, lint, and other foreign material. It is equipped with a removable basket/strainer which should be cleaned daily. It is recommended that a spare basket be used so that the pump is not shut off for extended periods of time during cleaning.

IV. PUMP – The pool/spa pump is the "heart" of the re-circulation system. The typical pump is a centrifugal pump. Water is drawn into the pump to the eye of the impeller. The water is then thrown from the outer perimeter of the whirling impeller by centrifugal force. This adds energy to the water in the form of velocity and drives the water into the chamber which encloses the pump. The energy is converted to pressure when the water passes through the chamber (volute) into the piping system.

Centrifugal pump performance is measured by two forms of output: flow rate, expressed in gallons per minute (gpm) and pressure head, expressed in pounds per square inches (psi) or feet of head. To perform correctly, a pump must provide proper flow rate as well as proper pressure head.

It is important to understand that the lower pressure at which a centrifugal pump must operate, the greater flow it produces. The higher the pressure, the lower the flow of water the pump can deliver. A pump must provide pressure equal to or greater than the resistant head of the system.

How is the pump performance affected? When a pump is operating with a clean filter it will produce more flow than when the filter is dirty. Also, the turnover rate will increase as the filter flow is restricted by debris. To maintain a consistent turnover rate, you must control the flow with a throttling valve.

The speed of the motor also affects the pump performance. The flow rate increases in direct proportion to an increase in speed. The pressure increases by the square of the change in speed and the horsepower requirement increases by the cube of the change in speed. For example: if the speed of a pump was doubled from 1500 rpm to 3000 rpm, the rate of flow would double, the pressure would increase four times, and the horsepower requirement would increase eight times.

How do you select the appropriate size pump for your re-circulation system? Remember that a public swimming pool should be capable of re-circulating the entire volume of the pool in **6** hours.

- Sand filters should be equipped with a pump capable of filtering 3 gallons per minute and backwashing 12-15 gallons per minute for each square foot of filter surface.
- High rate sand filters require a pump which will provide 15-25 gallons per minute for each square foot of filter surface for both filtering and backwash.
- Diatomaceous earth filters require a pump rate of 1-2 gallons per minute per square foot of surface area and may require no backwash flow.

A pump which operates against 50 ft. head (22psi) is usually sufficient for conventional sand filters. High rate sand and diatomaceous earth filters may require a pump head up to 100 ft. (43 psi). A general formula for figuring pump size is:

$$\text{HP (horsepower)} = \frac{\text{gpm X head in feet}}{\text{3960 X pump efficiency}}$$

(Approximately 50 X HP will give gpm at 50 ft. total dynamic head)

The pump should be designed to ensure that water is maintained in the pump rather than air. This can be done with check valves or self priming devices. Failure to maintain water in the pump will cause problems with pump operation and uneven flow patterns.

V. FILTERS – Filtration is physically removing dirt, debris, and algae. Filtration is accomplished with a filter. A variety of filters may be used for continuous water filtration. Filters are classified according to operational type (pressure or vacuum) or media (sand, or diatomaceous earth). See (**Figures 2, J and K).**

In a pressure system, water is delivered to the filter after reaching the pump so it will be under pressure. In a vacuum system, the water is filtered before reaching the pump. Vacuum filters are generally larger in size with slower flow rates. Pressure systems are more commonly used.

The performance of a filter is measured in terms of filter area and filter rate:

- The **filter area** is the total area (square feet) of filter media surface through which water can flow.
- The **filter rate** is the rate at which water will pass through one square foot of filter area (gpm/sq ft.)

The given filter rate and filter area of a specific filter determines the **flow rate.** The flow rate will directly affect the efficiency of the filtration and backwash process. In general, a good filter should remove all particles larger than 10 micrometers at sufficient flow rate to provide an adequate turnover rate.

Because sand filters are the most widely used filters in public pools/spas this manual will limit discussion to only sand filter operation.

SAND FILTERS – Filtering water through a layer of fine sand is one of the oldest forms of filtration. Dirt particles in the water are trapped and held in the very small openings between the grains of sand. Gelatinous and oily substances also cling to the grains of sand. The coagulation of these particles actually increases the filtering efficiency of the sand in capturing very small particles. (**Figure 2 L)** shows the flow pattern of water through a typical sand filter.

The different components of two modern types of sand filters, the conventional sand filter and high-rate sand filter, are illustrated in (**Figures 2 M and 2 N)**. The component that is located below the bottom layer of the sand or gravel and collects filtered water to be returned to the pool/spa is called the underdrain. The underdrain distributes the collected water evenly from the bottom of the filter to the pool inlets. The underdrain is made up of a collector or screen and piping. The underdrain is easily damaged if the re-circulation system is not allowed to “rest” between backwash and filtration operations. Sand from a damaged underdrain can collect around the pool inlets in the interior of the pool.

The area between the top of the sand bed and the top of the filter tank is called the freeboard. This area permits expansion of the sand bed during backwashing and prevents the sand from being washed out of the filter.

Above the free board is a baffle that evenly distributes the water entering the filter across the surface of the sand bed.

A comparison of the two basic designs of sand filters (conventional and high rate sand) show several differences with filter rates being the most significant. Some of these differences are explained below and in Figures (**2M and 2 N).**

Conventional sand filters

- **Slow rate or gravity sand filters** – are primarily found on old municipal pools with slow rate of flow (1/2 – 1 gpm/sq ft of filter area). They are filled with graduated layers of sand ranging from coarse sand in the bottom layer to fine sand on the top layer. These layers of sand are supported by successive layers of gravel with the largest size gravel on the bottom.
- **Rapid rate sand filters** – were the first improvement to slow rate or gravity sand filters. They will also be found in municipal pools or old residential installations. Like the slow rate filter, rapid rate filters are also filled with graduated layers of sand. Rapid sand filter rates of 2-5 gpm/sq ft. make these filters more efficient than the slow rate filters. One problem associated with these filters is "channeling". Because of the increased movement of the sand grains, voids may be left in the sand bed and allow unfiltered water to pass directly to the underdrain.

High rate sand filters

- Evolved in the late 1950's. In the high rate sand filter, water enters the filter through several holes and reflects off the top of the tank. Since the water is distributed more evenly and at a faster rate, sand migration and channeling do not occur. High rate sand filters have a filter rate of 15-25 gpm/sq ft.

During filtration, as dirt particles begin to accumulate on the sand bed, the flow of water through the filter will decrease as a result of the pressure differential across the sand bed. When the water flow becomes too low, it will be necessary to clean or **backwash** the filter. Two pressure gauges, one on the influent and one on the effluent pipe, will show the pressure change that indicates time to backwash, according to the manufacturer's specifications.

As a rule of thumb, the filter should be backwashed when the difference between the influent and the effluent gauge readings in 7 to 10 psi for a rapid sand filter and 10 to 20 psi for a high rate sand filter. If the filter has only an influent pressure gauge, record the reading at the beginning of the filter cycle. When the pressure increases 3-5 psi for a rapid sand filter or 5-10 psi for a high rate sand filter, the filter should be backwashed. Other factors also influence the length of time between filter runs: bather load, location of the pool and algae growth.

As backwashing implies, water entering the filter is diverted to the bottom of the tank which causes a reverse flow upward through the sand bed. (**See Figure 2 L)** Sufficient flow rates are required to produce a scouring actions so that dirt is physically rubbed from the sand surfaces. To get this scouring action, conventional sand filters must be capable of providing a backwash flow rate of 12-15 gpm/sq ft. of filter area. High rate sand filters require a backwash flow rate of 15-25 gpm/sq ft.

STEPS FOR BACKWASHING:

1. Turn off pump
2. Manually close the appropriate valves for reversal of flow or turn an automatic control valve to the backwash position.
3. Turn the pump on and allow it to run until water appears clean as seen in the sight glass.

4. If it is a manual system turn the pump off. If an automated system is utilized, turn the automatic control valve to the rinse position. Turn the pump on for 20-30 seconds to reset the sand bed and send any dirt residue to the waste line. Shut off the pump.
5. Manually adjust the appropriate valves for filtration or return the automatic control valve to the filter position. Turning the pump back on resumes the filter cycle.

PROBLEMS:

1. Mudballs are caused by insufficient flow rates or time of backwashing. Accumulations of debris build upon the filter surface and reduce the area available for backwashing.
2. Calcification in hard water areas is also caused by insufficient flow rates or time of backwashing. Both problems are corrected by chemical treatment or replacement of the filter sand.

The performance of the sand filter can be enhanced with the addition of aluminum sulfate synthetic polyelectrolytes or polymeric flocculants. These additives will form a gelatinous substance which attaches to dirt particles when proper pH and total alkalinity are present. (pH of 7.8 – 8.0 & TA of 80 ppm). Diatomaceous earth can also be used to improve filter performance. Flocculants are generally not used in high rate sand filters because too much dirt will be captured on the top layer of sand requiring more frequent backwashing.

An important safety device on pool/spa filters is the air relief valve. This valve releases pressure that builds up in the filter. If air is allowed to build up unchecked in the filter, it will try to penetrate the filter bed. This will “tumble” the filter bed causing the sand and gravel to mix at various levels. All filters should have an air relief valve to “bleed” the air from the tank.

VI. FLOWMETER – All public pools and spas should be equipped with a rate of flow controller of flowmeter. These devices are designed to measure the flow rate through the circulation system in gallons per minute. The flowmeter can indicate impediments in the flow pattern or a need for backwashing. It should be sized for the circulation system and placed in the longest length of pipe on the return side of the system. The flowmeter is usually located after the filters in order to calculate flow rate just prior to returning water to the pool/spa.

VII. HEATERS – All spas have heaters. A swimming pool may or may not have a heater. There are 4 basic types of heaters for pools and spas:

- Gas/oil heaters
- Electric immersion element heaters
- Heat pumps
- Solar heaters

One major concern with the installation of a heater is maintenance of pH. Too high a pH can cause the formation of scale deposits. Too low a pH can cause corrosion.

VIII. CHEMICAL FEEDERS - Chemical feeders are another optional piece of equipment in the recirculation system. They are installed on the discharge side of the pump and introduce chemicals automatically into the water. Chemicals added through feeder include chlorine or other disinfecting agents, or soda ash and acid for pH adjustment.

IX. RETURN INLETS – Return inlets are devices that return filtered, disinfected water back to the pool. The inlet should be adjustable and located 10-15 inches below the pool overflow level to prevent loss of disinfectant.

In summary, water should flow uniformly out of the pool via the skimmers or gutters to the filter where physical cleaning occurs. The water is then disinfected (biologically cleaned) and returned to the pool. The pump drives this flow and should be capable of providing the recommended turnover rate. The goal is to deliver pool water which is clean, clear and free of disease causing organisms. To reach this goal, knowledge of the recirculation system and its equipment is required. It is recommended that flow chart diagram and equipment specifications sheets are posted in the equipment room to assist you with your daily operations. Additionally, all equipment should be identified and color coded.

Chapter 3

Disinfection

SWIMMING POOL WATER DISINFECTION

Since swimmers swallow some of the pool water they swim in, the water must meet safe drinking water standards. Organic matter and bacteria are constantly being added by swimmers and therefore a sufficient disinfectant residual must be maintained.

The Portsmouth Health Department adheres to the Virginia Department of Health Water Quality Standards *12 VAC 5-462-290* where the free available chlorine residual for pools is continuously maintained within the range of **1.0 – 3.0 parts per million (ppm)**, and bromine levels are maintained at **2.0 - 4.0 ppm**. Spas/hot tubs can maintain a free available chlorine range of **1.0 – 5.0 ppm**, and bromine levels of **2.0 – 10.0 ppm**. Other disinfectants may be used if approved by the local health authority.

A bacteriological water sample analysis is required if your pool water source is from a private well. The analysis will check to determine the presence of coliform bacteria which refers to a category of bacteria commonly found in soil and in the intestinal tracts of animals. Some coliform bacteria are harmful (pathogenic) and others are not (non-pathogenic). A coliform count of greater than 0 indicates a possible water quality problem with the water supply or with the disinfection process. The Portsmouth Health Department requires an annual water sample be submitted to a state certified laboratory for analysis prior to the opening of any public swimming pool using well water. A satisfactory water analysis of the sample must be performed prior to the issuance of the permit.

CHLORINATION

Chlorine is one of the most widely used disinfectants because it's relatively inexpensive, commonly available, and a very good disinfectant at low concentrations (1.0 to 3.0 ppm). Chlorine acts as an oxidizer which is a type of compound which chemically "burns" away other compounds such as bacteria, fungi, viruses, and algae. When chlorine is added to pool water, it reacts as follows:

Cl_2 (Chlorine) + H_2O (Water) ⇨ HCL (Hydrochloric Acid) + HOCl (Hypochlorous Acid)

The Hypochlorous acid further reacts with water to form the following:

HOCl + H_2O ⇨ H^+ + OCL-

Hypochlorous Acid (molecular form) + Water Ion ⇨ Hydrogen Ion (ionized form) + Hypochlorite

Hypochlorous acid in its molecular from (HOCI) is a potent bactericide but as it breaks down into its ionized form, it becomes much weaker. In fact, the ionized form of Hypochlorous acid is 100 times slower than the molecular form. In order to achieve satisfactory disinfection of pool water, the Hypochlorous acid needs to remain in its molecular form. This can be controlled by regulating the pH of the pool water.

Pool water with a pH below 7.0 will provide a greater rate of disinfection than pool water with a higher pH. Unfortunately, operating a pool with a pH below 7.0 will cause problems for bathers as well as for pool maintenance and construction. The pH of the human eye is 7.4 and water with a different pH will cause bathers to experience burning and irritation to their eyes. Low pH, below 7.0 , will also cause coagulants used in sand filters to dissolve, will cause pipes to corrode, will etch the surface and grout of pool interior surfaces, and will encourage algae to grow. It is for these reasons that pool water should be maintained at a pH of 7.2 to 7.8 with the optimum pH being 7.4. The effectiveness of the chlorine is diminished to about 50%, but it is a necessary trade off.

pH CONTROL

The act of chlorination, as well as the type and concentration of chlorine or other disinfectant used, bather load, and weather conditions can impact on the pH of the pool water. Temperature does not directly affect pH. From time to time, it may be necessary to add additional chemicals to the pool water in order to return the pool pH to the recommended 7.2 to 7.8.

Chemicals used to raise pH are sodium carbonate (soda ash), sodium bicarbonate (baking soda), and sodium hydroxide which is seldom used as it can be dangerous to handle.

Chemicals used to lower pH include sodium bisulphate, CO_2 (carbon dioxide), and muriatic acid.

The addition of chemicals to alter pH should not be considered until other chemical parameters of the pool have been brought into normal operating range. Excessive or insufficient disinfection will cause pH values to fluctuate from the desired range and premature correction of pH will cause an overcorrection of pH problems.

CHLORINE DEMAND

The chlorine in Hypochlorous acid is an active oxidizing agent which will combine readily with other substances to “burn” them away. Swimming pool water contains many different substances such as bacteria, body oils and waste products such as sweat and urine, and organic matter such as leaves. In the process of oxidation, these products are destroyed but in the process, the chlorine is also used up. The amount of chlorine which must be added to a pool at any given moment to react with and eliminate all of these substances is called the chlorine demand.

FREE RESIDUAL CHLORINE

After the chlorine demand is satisfied, additional chlorine is added so that chlorine is readily available in case other wastes should enter the pool. The amount of chlorine not yet used is called free residual chlorine. It reflects the amount of molecular as well as ionized forms of chlorine which are present in the pool water. As stated earlier, the Portsmouth City Pool Code requires a free residual chlorine content of 1.0 ppm continuously.

COMBINED CHLORINE

Residual chlorine may combine with nitrogen containing substances, such as ammonia, to produce compounds which are much slower oxidizers. Nitrogen is a common byproduct of sweat and urine which commonly finds its way into pool water. In effect, the chlorine unites with the nitrogen forming a secondary product. These chlorine/nitrogen products are referred to as combined chlorine or chloramines. Chloramines are very poor oxidizers and are only $1/12^{th}$ as effective as a bactericide. In addition, they can result in eye irritation and a strong chlorine odor around the pool area. A build up of chloramines in pool water signals the need for super chlorination or “shocking” of the pool water. Excessive chloramines may also cause a cloudy, dull appearance to pool water. Combined chlorine may be determined by subtracting the amount of free residual chlorine from the amount of total chlorine. For example:

Total Chlorine – Free Residual Chlorine = Combined Chlorine

The DPD pool water test kit does not measure combined chlorine directly. Therefore, separate testing for total chlorine and free residual chlorine is necessary when calculating the combined chlorine level.

TOTAL CHLORINE

Total chlorine is the sum of the residual chlorine and the combined chlorine.

SUPERCHLORINATION

Combined chlorine residuals tend to form in pool water and create a nuisance for bathers and operators. These chloramines can be burnt out of the pool water through the practice of periodic super chlorination of the pool water. Super chlorination means raising the free chlorine residual of the pool water to 5 to 10 ppm of chlorine in order to “burn” off these objectionable byproducts. The addition of chlorine to the pool saturates the chloramines with enough disinfectant action to be destroyed. In the process of burning away the chloramines, the excess chlorine is also consumed allowing the pool water to return to a more normal chlorine level. This addition of chlorine to pool water in order to saturate the combined chlorine is also referred to as “breakpoint chlorination”.

FORMS OF CHLORINE

Chlorine is most commonly available in solid, liquid or gas. Each form of chlorine has advantages and disadvantages and the selection of the most appropriate form largely depends upon personal preference.

SOLID CHLORINE – (CALCIUM HYPOCHLORITE)

Solid chlorine is also commonly referred to as calcium hypochlorite. It is a dry white compound which is available either in compressed tablets or in granular form. Calcium hypochlorite provides approximately 70% available chlorine when mixed with water and remains fairly stable when stored cool and dry.

Calcium hypochlorite will cause a rise in the pH of the pool water and will contribute to the total alkalinity and hardness of the pool water over time.

Calcium hypochlorite is also very reactive to moisture and other compounds and must be handled and stored with care. A small amount of water coming in contact with this dry product will create explosive reactions which will also produce deadly chlorine gas as a byproduct of combustion. Just a small amount of soda, perspiration, suntan lotion, Motor oil, grease, paint, solvents, dirty rags, fertilizer, or just about any organic substance will react violently with dry chlorine, especially granular chlorine. Granular chlorine is also highly reactive to fire, therefore cigarette smoking or other flame sources near dry chlorine is dangerous.

Remember, chlorine is an oxidizer and oxidizers generate oxygen during combustion. This makes extinguishing chlorine fires difficult.

The following precautions should be taken when using and storing calcium hypochlorite:

- Always read the label carefully before using the product.
- Never mix anything with chlorine except water. **NEVER ADD WATER TO CHLORINE**- always add a **SMALLER** volume of chlorine to a **GREATER** volume of water. **NEVER USE GRANULAR CHLORINE IN AN EROSION FEEDER (CHLORINATOR) - IT WILL EXPLODE!** Store chlorine away from heat and flame and be careful not to contaminate chlorine with any other compounds.
- Keep chlorine in a closed waterproof container stored away from pumps and filter.
- Never reuse chlorine containers to store other chemicals or compounds. The residual chlorine in the container may react adversely with the other compound.

- The acceptable practice of maintaining the required chlorine concentration is by the use of an automatic chemical feeder (i.e. chlorinator).

  DO NOT attempt to maintain daily chlorine levels by**:**
  - placing chlorine tablets directly in the pool, return skimmers, or gutters.
  - pouring liquid chlorine directly into the pool, return skimmers, or gutters **(unless required for superchlorination).**
  - pouring a granulated chlorine slurry mix directly into the pool, return skimmers, or gutters **(unless required for superchlorination).**
- Always use protective clothing when handling chlorine. Wear chemical-resistant gloves & apron, goggles, and a NIOSH-approved cartridge respirator to prevent chlorine dust from coming in contact with damp skin and lungs.

LIQUID CHLORINE – (SODIUM HYPOCHLORITE)

Liquid chlorine is also known as sodium hypochlorite. It is a clear, slightly yellow liquid which provides 15% available chlorine. Although not as strong as solid chlorine, liquid chlorine is still a very strong product. Household liquid bleach, which can be very irritating to lungs and skin, is only 5% available chlorine. The liquid chlorine products sold for pool use are three times stronger than household bleach.

Liquid chlorine is relatively unstable and breaks down into useless byproducts when exposed to heat or sunlight. Considering the average temperature of many outdoor pool chemical storage areas, it would be wise to store only limited quantities of liquid chlorine.

Liquid chlorine is also very basic in nature and will greatly increase the pH of the pool water. For this reason, many pool operators use automatic muriatic acid feeders or CO_2 (carbon dioxide) feeders in conjunction with the liquid chlorine feeder to maintain a pH level between 7.2 and 7.8.

The following precautions should be followed when using and storing sodium hypochlorite:

- Always read the label and follow the manufactures recommendations for the use and storage of this product.

- Always wear gloves and an apron when working around liquid chlorine. Do not allow this product to come in contact with skin or clothing. Any contact with skin should be washed off immediately with large quantities of water.

- Always store liquid chlorine in a well ventilated area. Do not allow liquid chlorine to come in contact with any acid as chlorine gas will be generated which is highly poisonous.

CHLORINE GAS

Under normal atmospheric conditions, chlorine gas is a heavier than air, greenish colored gas that is extremely toxic and has a very irritating odor. When placed under pressure, it liquefies and can be packed economically into metal cylinders. When connected to a gas chlorination system, the compressed gas expands quickly when introduced to pool water. Gas chlorine is capable of quickly raising the chlorine level of even large pool volumes. For this reason, gas is often used in large water recreation parks. Chlorine gas creates an acid compound when mixed with water therefore it lowers pool pH considerably.

Although gas chlorine is economical and very efficient for disinfection, the safety problem's it presents makes chlorine gas impractical for most pool operators. Chlorine gas is absolutely deadly. It takes only 0.1% chlorine gas in the air to kill a person. The following guidelines are only minimum standards for the use of chlorine gas and additional safety requirements may be necessary based upon local regulations:

- Chlorine gas cylinders require storage in specially constructed buildings which are fire resistant, have outward opening doors, allow for visual inspection of the room interior from outside the room, and must have sufficient ventilation either mechanical or through vents.

- Chlorine gas cylinders must be chained or strapped to a rigid support to prevent accidental tipping or possible damage to the cylinder.

- Chlorine gas detectors, usually composed of commercial grade ammonia, must be present in the pump room.

- A gas mask approved for chlorine must be available outside the chlorine room at all times.

- Swimming pool operators should receive specific emergency training in case of leaks or other emergency situations concerning the chlorine gas.

STABILIZED CHLORINE

Sunlight and heat can degrade chlorine quickly. On a hot sunny day when the bather load is high, the free available chlorine in the pool is consumed rapidly. To help protect the chlorine from the adverse effects of the heat and sun, cyanuric acid (isocyanuric acid) may be added to the pool water. Cyanuric acid creates a bond with the chlorine creating a more stable product. It creates, in effect, a type of chloramines although the cyanuric acid/chlorine product is far more effective as a disinfectant than the nitrogen/ chlorine chloramines. It is effective in a concentration of 40 to 60 ppm when dissolved in pool water and

is measurable with test kits designed to measure cyanuric acid. Several items should be considered when utilizing cyanuric acid:

- Once added, cyanuric acid remains in the pool water until it is lost through backwashing or other forms of water loss.

- Using a chlorine product routinely which contains cyanuric acid may cause a cyanuric acid build up to occur in the pool. This is referred to as "over stabilized". "Over stabilized" pools become a problem because chlorine added to superchlorinate the pool may become trapped in the pool water and unavailable to burn off the organic byproducts that it was intended to oxidize. Chlorine levels can rise to excessive levels and eventually cause irritation problems for the bathers and can cause corrosion to pool plumbing and etching of pool interior surfaces. For this reason, it is recommended that non-chlorine products be used for superchlorination on stabilized pools.

FECAL INCIDENT RESPONSE

There may be times when a fecal accident occurs in the pool. It is important to know how to properly address such an incident. Turn to the next page to review "Fecal Incident Response" and "Increasing Chlorine Levels Up to 20 PPM" guidelines.

FECAL INCIDENT RESPONSE

FORMED STOOLS	DIARRHEA
1 CLOSE POOL: EVACUATE ALL PATRONS FROM POOLS ON SAME FILTER.	1 CLOSE POOL: EVACUATE ALL PATRONS FROM POOLS ON SAME FILTER.
2 REMOVE AS MUCH FECAL MATTER AS POSSIBLE. (NET OR SCOOP) (VACUUMING NOT RECOMMENDED)	2 REMOVE AS MUCH FECAL MATTER AS POSSIBLE. (NET/SCOOP) (VACUUMING NOT RECOMMENDED)
3 RAISE CHLORINE TO BETWEEN 2.0 – 3.0 PPM, PH 7.2 - 7.5	3 RAISE CHLORINE TO 20.0 PPM, PH 7.2 - 7.5
4 MAINTAIN THESE CHEMICAL LEVELS FOR 30 MINUTES.	4 MAINTAIN CHLORINE 20.0 PPM, PH 7.2 – 7.5 FOR A MINIMUM OF 12.75 HOURS.
5 AFTER 30 MINUTES: VERIFY AND RECORD CHLORINE AND PH CONCENTRATION LEVELS.	5 ENSURE FILTRATION SYSTEM IS OPERATING WHILE POOL REACHES AND MAINTAINS CHLORINE DISINFECTION.
6 *REOPEN POOL	6 BACKWASH FILTER THOROUGHLY AFTER THE 12.75 HOURS.
7 DOCUMENT INCIDENT: DATE, BEGINNING & END TIMES, TYPE, STEPS TAKEN, LENGTH OF TIME CHLORINE ≥ 2.0 PPM. *NOTIFY HEALTH DEPT*	7 AFTER 12.75 HOURS: RETURN CHLORINE LEVEL TO NORMAL LEVEL (1.0 – 3.0 PPM). VERIFY AND RECORD CHLORINE AND PH CONCENTRATION LEVELS.
NOTE: *VOMIT INCIDENTS ARE TO BE TREATED IN THE SAME MANNER AS A FORMED STOOL INCIDENT!*	8 *REOPEN POOL
	9 DOCUMENT INCIDENT: DATE, BEGINNING & END TIMES, TYPE, STEPS TAKEN, LENGTH OF TIME CHLORINE @ 20.0 PPM. *NOTIFY HEALTH DEPT*

CONTACT THE PORTSMOUTH HEALTH DEPARTMENT'S ENVIRONMENTAL HEALTH SERVICES FOR ALL POOL QUESTIONS

(757) 393-8585 EXT. 8585

Increasing Chlorine Levels Up to 20 PPM

When it is necessary to increase the level of chlorine in a swimming pool or spa, the following procedure should be used:

1. Determine the free available chlorine (FAC) in the pool water in ppm (mg/l). Using the DPD test kit, following the test kit directions.
2. Determine the amount in ppm (mg/l) you want to increase the chlorine.
3. Determine the ppm (mg/l) change using the following to increase: Desired ppm - current ppm (FAC) = ppm (mg/l) change. Example: Desired ppm (20.0) - Current ppm or FAC (1.0) = 19 ppm (mg/l) change.
4. Identify the chlorine compound to be used to increase the chlorine level. Use product label chemical dosage, product label chemical adjustment, or no product label chemical adjustment formulas to determine the amount of product to use to produce 1 ppm (mg/l) free chlorine per 10,000 gallons of pool water.
5. Make sure the pH is within the acceptable range of 7.2-7.8. These chlorine compounds will significantly change the pH and affect the effectiveness of the chlorine.
6. Determine the volume of water the pool holds.

Product Label Chemical Dosage Equation:

Total Amount of Chemical to Add = (Amount from product label) x (Actual Pool Volume in gallons) ÷ (Gallons from product label)
An example: You have a 95,000 gallon pool and decide to use an algicide. The label states: Use 16 fluid ounces per 10,000 gallons of water. How much chemical do you add? Total Amount of Chemical to Add 16 ounces × (95,000 gallons ÷ 10,000 gallons) Total Amount of Chemical to Add = 152 fluid ounces. 152 fluid ounces ÷ 128 fl.oz/gallon = 1.1875 gallons rounded to 1.2 gallons.

Product Label Chemical Adjustment Equation:

Total Amount of Chemical to Add = (Amount from product label) x (Actual pool volume in gallons÷ Gallons from product label) x (Desired chemical change in ppm ÷ ppm change from product label)
An example: You have a 60,000 gallon pool that has a free available chlorine level of 1 ppm (mg/l). You want to raise the chlorine level to 10 ppm. The product label states that 20 ounces of calcium hypochlorite will raise the chlorine level by 10 ppm in 10,000 gallons of water. How much calcium hypochlorite do you add? Determine the amount of desired chemical change: Desired Chemical Change in ppm = 10 (Chemical level you want to achieve in ppm) – 1 (Current Free Available Chlorine ppm) Desired Chemical Change = 9 ppm. Apply the formula: Total Amount of Chemical to Add = 20 oz. × (60,000 gallons ÷ 10,000 gallons) × (9 ppm ÷ 10 ppm) Answer 108 oz. or 108 ÷ 16 = 6.75 pounds of calcium hypochlorite.

Continued on next page

Increasing Chlorine Levels Up to 20 PPM (Cont.)

No Product Label Chemical Adjustment Equation:

If the chemical was purchased in bulk, there may not be label with dosing instructions.
In order to determine the number of ounces of compound per 10,000 gallons of water that is necessary to raise levels by 1.0 ppm can be calculated using the following:
1.0 ppm equals about .083 lbs of chemical per 10,000 gallons of water* or 1.3 oz per 10,000 gallons.

An example:
Given: Free Available Chlorine = 1 ppm (mg/l)
Product is Sodium Hypochlorite and label shows 12% available chlorine.
How much sodium hypochlorite must be added to a pool containing 40,000 gallons of water to raise the chlorine level to 3.0 ppm (mg/l)?
Obtain the percent of available disinfectant in the compound = 12%.
Change the percent to decimal by moving the decimal two places to left = .12
Divide 1.3 by the decimal of the percent of available disinfectant. 1.3 ÷ .12 = 10.8 oz of sodium hypochlorite to produce 1 ppm of free chlorine for 10,000 Gallons.
Apply the desired chemical change formula:
Desired Chemical Change in ppm = 3 (Chemical level you want to achieve in ppm) – 1 (Current Free Available Chlorine ppm)
Desired Chemical Change = 2 ppm.
Apply the product label adjustment formula:
Total Amount of Chemical to Add = 10.8 oz. × (40,000 gallons ÷ 10,000 gallons) × (2 ppm ÷ 1 ppm)
Answer 86.4 fl. oz. or 86 ÷ 128 = 0.67 gallons of Sodium Hypochlorite.

Chapter 4

Water Chemistry

WATER

Water comprises over 60% of the earth's surface. However, no two bodies of water are exactly alike. Each contains different levels of minerals, organic compounds and other elements which have dissolved in it to make it unique.

On the most basic level, pure water contains only oxygen and hydrogen. Pure water is water that has had all the minerals, etc. removed or "distilled" out of it. Pure water has a pH of 7.0, which means that it is neutral. Only after minerals and other things are added to it does it become acidic or basic.

WATER BALANCE

Water that has no minerals or other elements in it is not necessarily happy or "balanced" water. Just as we humans need various elements to be healthy or happy, water also needs certain elements to be happy or balanced. For safe, effective operation of a swimming pool, the water must be balanced. Without balanced water, a swimming pool can undergo rapid change or may become detrimental to the health of the swimmers or the equipment in the pool system. Therefore, when filling a pool at the beginning of a season, it is important to get the water in balance as soon as possible. Water which is in balance is said to be neither corrosive nor scaling.

Water balance involves five (5) main factors which include: **pH, total alkalinity, calcium hardness, temperature and total dissolved solids.** When one or more of these factors is out of line, the water is said to be out of balance. If the level is below acceptable levels, the water can be corrosive. This means that the water will seek to satisfy its "hunger" or low level by attacking things that it is in contact with such as pool walls, metal equipment or possibly even bathers. If the level(s) of the factor(s) are too high, the water is said to be scaling and will attempt to get rid of the excess by forming a precipitate on the bottom of the pool, in the water, or as a scale that sticks to the inside of the pipes.

SATURATION INDEX (LANGLIER INDEX)

There have been many attempts by chemists to determine what balanced water is through the use of formulas. The best known of these is the Saturation Index otherwise known as the Langlier Index. By assigning values to the level of each of the five (5) components of water balance, this formula can tell you whether the water is in balance, is corrosive, or is scaling. The generally acceptable range is 0.0 to +0.5. A negative value usually indicates corrosive water and a value greater than +0.5 is usually scaling.

The formula is:

S.I. = pH + T.F. + C.F. + A.F. - T.D.S.F

S.I. = saturation index
pH = pH of water
T.F. = temperature factor
C.F. = calcium factor
A.F. = alkalinity factor
T.D.S.F. = total dissolved solids factor = 12.1 or 12.2

Less than 1,000 ppm (mg/L)	1,000 ppm (mg/L) or greater
12.1	12.2

The temperature factor, calcium factor and alkalinity factors can all be found on the chart below.

Temperature (degrees F)	Temperature Factor	Calcium Hardness (ppm)	Calcium Factor	Total Alkalinity (ppm)	Alkalinity Factor
32	0.0	5	.3	5	.7
37	0.1	25	1.0	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	2.0
66	0.5	150	1.4	150	2.2
76	0.6	200	1.9	200	2.3
85	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

pH

pH is the most important aspect of water chemistry and balance. Its level determines how much chlorine is needed and how effective it will be in eliminating harmful bacteria and organisms that enter the water. The other elements of water balance are directly affected by the pH level. It also has a significant effect on bather comfort or discomfort while in the water. Pool equipment too, can be damaged or destroyed if the pH is not maintained within an acceptable range.

On the most basic chemical terms, pH is a measure of the hydrogen ions in water. In laymen's terms, it is a measure of the acidity or baseness of a substance, in this case, water. pH is measured on a scale of 0 - 14. The exact middle of this scale is 7. At this point, water is said to be neutral. Anything below 7 (0 - 6.9) is said to be acidic. The further to the left of 7 (the closer to 0), the stronger or more acidic is the solution. For instance, a pH of 2 is much more acidic than a pH of 5.

As one goes to the right of 7, the pH is said to be basic. The closer you get to 14, the stronger the base. For instance, a pH of 12 is a stronger base than a pH of 9. The human body has a pH of 7.4 - 7.6. Therefore, the idea pH of pool water is the same, 7.4 - 7.6. However, it is generally recognized that pool water with a pH of 7.2 - 7.8 is the acceptable range for proper operation. When the pH level is outside of this range, the operator **must** take action to adjust the pH back into the acceptable range.

There are a variety of methods for adjusting the pH in pool water. All of them require the addition of some compound or chemical which will counteract the acidity or baseness of the water. These chemicals can be liquids, solids (powder) or gases. It is important to remember that whenever chemicals are being handled, utmost precaution must be taken and directions for proper handling must be read and followed by the operator.

When the pH of pool water is too low (< 7.2) and must be raised, a chemical with a higher pH (>7.8) or a base must be added. The most commonly used chemical for this is called soda ash otherwise known as sodium carbonate. It generally comes as a white powder somewhat like flour. The amounts needed and proper procedures for adding this and other chemicals will be covered later in this chapter. When the pH is too high (>7.8) and must be lowered, an acidic substance (< 7.0) must be added. The most common chemicals used to lower pH are muriatic acid (liquid) and sodium bisulfate (powder). Both are highly corrosive and must be handled with caution.

Another effective, although not commonly used, method of lowering the pH of pool water is the use of carbon dioxide (CO_2). When CO_2 is added to water, it forms carbolic acid which lowers the pH. CO_2 is best used in situations when the pool water constantly moves towards a high pH. This is generally the case when liquid (sodium hypochlorite) chorine is used. By constantly adding CO_2, it will continually balance the effects of the chlorine and maintain an acceptable pH level.

pH can be effected by any number of things it comes in contact with. Things such as urine from bathers, rainfall (acid rain), gas chlorine and bromine can all make a pool's pH drop. On the other hand, things such as liquid chlorine, new plaster in a pool, an algae bloom, and sodium bicarbonate can all cause the pH of the pool water to rise. Sunlight on the other hand, has no effect on pH.

As you can see, pH can be easily influenced during the course of a normal day. It is also evident that pH is very volatile and can change rapidly. Therefore, it is imperative that the pool operator, using an approved chemical test kit, regularly test and document the pH of the pool water. It is required in the Portsmouth City Pool Code that this, as well as the chlorine or bromine levels, be checked every two (2) hours at a minimum. It is also important to write down and record these readings in an operator's notebook. This documentation can prove to be beneficial for detecting trends in pool water chemistry, alerting the operator to possible problems, planning future changes or improvements and, if necessary, to act as support in case of any legal action involving patrons, bathers, etc.

TOTAL ALKALINITY

Total alkalinity of water is a measure, in parts per million, of the water's ability to resist a change in pH. This is also known as the "buffering capacity" of the water. It is composed of several different chemical compounds which include hydroxides, carbonates and bicarbonates. At the pH range desirable for pool water, 7.2 - 7.8, the bicarbonate compound is the predominate form. As you can see, pH and alkalinity are closely related. Generally, if the total alkalinity is high, the pH will also be high. Furthermore, if the alkalinity is high, it is very difficult to adjust the pH, if need be, without the addition of a significant amount of chemicals to the water. However, if the alkalinity is low, the pH of that water can change dramatically and rapidly with the addition of small amounts of chemicals or other agents to the water.

The acceptable range for total alkalinity is 80 - 120 parts per million. It is generally recommended that if the pH of your pool water tends to increase due to the effects of the chlorine, you use you should keep the alkalinity at 80 - 100 ppm. If the pH tends to fall during chlorination, you should maintain the alkalinity in the higher part of the range not exceeding 150 ppm. Remember that raising the alkalinity level will also increase the pH.

To lower total alkalinity, add either muriatic acid or sodium bisulphate to the pool water. However, the addition of acid into pool water will also lower the pH. Therefore, the pH should be monitored closely while lowering the alkalinity. What may happen in the case of high alkalinity is that after adding acid the pH will initially drop. After a short while the pH will "bounce" back up to a high level over 8.0. Only after the total alkalinity is lowered to an acceptable level will this bouncing effect cease.

To increase total alkalinity, add sodium bicarbonate.

It is important to remember that acids and bases may be directly added to pool or spa water as per label instructions as long as there are no people in the water and the pool or spa remains closed until the chemicals are completely dissolved or dispersed.

The table listed on the next page provides the proper amounts of sodium bicarbonate to add to pool water when raising the total alkalinity, and the proper amount of muriatic acid to add when lowering the total alkalinity of the pool water.

TOTAL ALKALINITY

RANGES AND ADJUSTMENTS
RANGE (ppm)

1. pH fluctuation
2. Corrosion
3. Eye irritation
4. Green water

1. Hard to adjust pH
2. Cloudy water
3. High pH

80-120 ppm

1	1	1	1	1	1	1	1
25	50	75	100	125	150	175	200

TOO LOW IDEAL TOO HIGH

To **raise** the total alkalinity using sodium bicarbonate, add the following amounts:

	Pool volume (number X 1,000 gallons)			
Desired increase (ppm)	1	5	10	25
10	2.5 ounces	12 ounces	24 ounces	3 ¾ pounds
20	5 ounces	24 ounces	3 pounds	7 ½ pounds
30	7.5 ounces	2 ¼ pounds	4 ½ pounds	11 ¼ pounds
40	10 ounces	3 pounds	6 pounds	15 pounds
50	12 ounces	3 ¾ pounds	7 ½ pounds	18 ¾ pounds
60	14.5 ounces	4 ½ pounds	9 pounds	22 ½ pounds
70	17 ounces	5 ¼ pounds	10 ½ pounds	26 ¼ pounds
80	19 ounces	6 pounds	12 pounds	30 pounds
90	22 ounces	6 ¾ pounds	13 ½ pounds	33 ¾ pounds
100	24 ounces	7 ½ pounds	15 pounds	37 ½ pounds

To **lower** total alkalinity using muriatic acid, add the following amounts:

	Pool volume (number X 1,000 gallons)			
Desired decrease (ppm)	1	5	10	25
10	2 ounces	10 ounces	21 ounces	3 ¼ pints
20	4 ounces	20 ounces	42 ounces	6 ½ pints
30	6 ounces	2 pints	4 pints	5 quarts
40	8 ounces	2 ½ pints	5 pints, 4 ounces	6 quarts, 1 pint
50	10 ounces	3 pints, 2 ounces	6 ½ pints	2 gallons

The effects of improper alkalinity levels can be detrimental to the pool, the equipments and the bathers. When it is too high not only does it resist change in pH, it can also cause cloudy water. When it is too low it can cause, in addition to rapid changes in pH, corrosion of pipes and plaster, eye irritation, staining of the pool and possibly green water.

Testing for total alkalinity can be done at the pool with a simple test kit. It usually requires adding a chemical called methyl orange to a sample of pool water. Once combined, it will change color which indicates the alkalinity level. However, some chemicals in the pool water such as cyanuric acid may cause problems with the accuracy of the test. Another option is to take a sample of your pool water to the company from which you purchase your pool chemicals. They are usually willing to test the water for you at no cost. They will then test all of the chemical levels. This, in turn, gives them the opportunity to sell the chemicals needed to correct any unacceptable levels. For novice operators, this is usually the best option, at least initially, to ensure accurate readings. Then after becoming familiar and confident with their own test kits, they can do these tests themselves at their pool. One important thing to remember is that if a sample of water is to be taken, it should always be put in a clean container, preferably glass. This ensures that there will be no residual chemicals in the container which may alter the rest results.

As was stated earlier, pH and total alkalinity are closely related. When it is found that both of these levels are out of the acceptable range it is recommended that the total alkalinity level be adjusted first. Once this is done the pH can then be safely adjusted to an acceptable level. Finally, when these two (2) criteria are within their acceptable ranges, the third and final criteria, calcium hardness, can be addressed.

CALCIUM HARDNESS

The “hardness” of pool water is determined by the amount of calcium compounds, usually calcium carbonate, in the water. When water has a high level of these compounds the water is said to be hard. When the concentration is low the water is said to be soft. One way to recognize hard water is by the inability to have soap lather when using hard water. The high calcium concentration prevents the soap from foaming up. Although soft water cannot be as easily recognized, it can be corrosive to pipes and especially to the plaster in the walls of the pool.

The simple fact is there must be some calcium in water for it to be “balanced.” If it does not have sufficient amounts of calcium dissolved in it, the water will literally seek out sources by corroding the surfaces it comes in contact with. The most readily available source is the calcium in the walls of the pool. Over time the plaster which lines the pool will be severely etched or deteriorated because of this. This will lead to rough surfaces inside the pool which are a hazard to bathers. At the other extreme, when the water is too “hard”, the calcium may actually precipitate or settle to the bottom of the pool or may form scale on the inside of pipes, heaters, sand filter and other equipment. As the scale builds up inside pipes and heaters, it puts additional strain on the pump, filter and heater.

The **ideal range** of calcium hardness is 200 - 300 parts per million (ppm), but the **acceptable range** is between 150 - 400 ppm. The level can be raised through the addition of calcium chloride. On the other hand, the only way to reduce the hardness level is to drain water from the pool and add fresh water with a lower hardness level. This will dilute the higher reading and lower the total hardness. Unfortunately, if the hardness level is very high, it may require draining a significant portion of the pool’s water to lower the hardness to an acceptable level. This again indicates the importance of testing pool water regularly and monitoring the levels of all of the components of balanced water. Many operators and pool companies overlook the importance of calcium hardness. However, to achieve truly “balanced” water as well as protect the pool and equipment, it must be adjusted and monitored throughout the pool season. The required level needed to balance your pool water will be largely determined by the pH and total alkalinity of the water. Therefore, of the three (3) criteria, calcium hardness should be the last item adjusted when balancing your water.

The Portsmouth Pool Code requires that total alkalinity and calcium hardness tests be made and recorded at least **weekly.**

Chapter 5

Testing, Records, and Pool Data

POOL WATER TESTING, MEASUREMENTS AND DATA

Pool water testing is one of the most important maintenance tasks involved in operating a pool. Operating a pool without testing is like driving a car with your eyes closed. You have no idea if there is enough disinfectant (chlorine) or if there is too much, if the pH is too high or too low. Furthermore, you will not know if the water is balanced with proper levels of total alkalinity or calcium hardness.

There are a variety of pool water test kits available to the pool operator. Of course, if the operator desires, expensive electronic meters and testers can be purchased and used for this purpose.

It is required in Portsmouth that ever pool has a test kit that, at a minimum is capable of measuring disinfectant (chlorine) level, pH, total alkalinity, and calcium harness. The test kit should also be capable of measuring both free available and total chlorine.

Pool test kits and the tests themselves are said to be colorimetric. This means, that as a result of conducting the test, the pool water sample will change color as an indication of the level of chlorine or pH. When conducting a test for pH, the color may range anywhere from yellow, which indicates a low pH, to orange and then to red which indicates a high pH.

When testing disinfectant (chlorine) levels the sample, depending on the type of test kit, will turn either yellow or pink. If the test turns yellow it is an indication that you are using an orthotolidine (OTO) test kit. Unfortunately, OTO test kits are <u>not</u> acceptable for use at Portsmouth public swimming pools for two reasons. First of all, OTO (orthotolidine) is a carcinogen as determined by the FDA. Secondly, OTO tests are very rapid and the yellow dye makes it difficult to distinguish between the free available chlorine and the total chlorine readings.

The chlorine test kit that is approved for use at public pools is called a **DPD** test kit. DPD, which stands for Diethyl-p-Phenylene Diamine, reacts with the disinfectant in the water to give a pink color. The intensity of the color indicates the level of the disinfectant. The color is simply compared to the scale on the test kit comparator to estimate the disinfectant level.

When testing for pH, the reagent used is called **phenol red**. This chemical can come in tablet or liquid form, as can the DPD reagents. Upon adding the phenol red to the pool water sample a color change will take place. As in the chlorine test, the resulting color must be compared to the scale on the test kit. Sometimes it is necessary to estimate the level because it will fall somewhere between two (2) colors on the comparator.

When using pool test kits there are many important points to remember and rules to follow:

1. **Read and follow the directions for your test kit. Each kit is slightly different. Any errors in conducting the tests and the way they are designed to be done may cause drastic changes and inaccuracies in the results.**

2. **Always clean the tubes or test kit before and after each use to insure they are free of any chemical residuals for the next test.**

3. **Always take the water samples from 12-18 inches below the surface of the pool. This insures a representative sample of the pool water and prevents contaminants floating on the surface from interfering with the test.**

4. **Do not take samples from corners or directly from in front of return lines. In the case of corners, these tend to be dead spots with poor circulation and not indicative of the rest of the pool water. With return lines, the water is just returning from the filter and chlorinator and will tend to give an elevated chlorine residual.**

5. **Pool test kits are not 100% accurate. They are simply tests meant to provide close estimations for the actual levels. However, always use fresh reagents. All reagents should be replaced at the beginning of each new season. Old reagents do not react properly and will give inaccurate results. Also protect and maintain the reagents and kits during the season. Sun and heat can drastically age and weaken reagents. Try to keep them in a cool, dry. Dark place whenever they are not in use.**

6. **Test the pool water frequently. Chlorine and ph levels should be checked every day before the pool is opened. After that they should be checked every two hours (2). It is important to remember that the more often pool water is tested, the more quickly, safely and easily improper levels can be corrected. Other chemical levels such as total alkalinity, calcium hardness and stabilizer (cyanuric acid) must checked weekly.**

7. **Always put the caps on the comparator tubes when testing. Do not use your fingers to cover them. Small amounts of chemicals on your fingers can dramatically affect the sample and give you faulty results.**

8. **Keep records of the tests you run and the results. Accurate records are required by the Health Department. Furthermore, records provide documentation for management which can be used for many reasons which will be discussed later.**

CYANURIC ACID

Cyanuric acid, or stabilizer as it is commonly known, should be added to pool water at the beginning of the pool season. This is only, of course, if you have an outdoor pool since stabilizer is not used in indoor pools. The stabilizer level will usually decrease slowly as time passes. This is because every time you backwash the pool you are losing some cyanuric acid. Then again, if you are using stabilized chlorine (dichlors or trichlors), the level may remain fairly consistent. To be sure you must test the water.

Cyanuric acid test kits may be included in some of the larger pool test kits or may be purchased separately. Once the proper level of stabilizer is achieved (40 – 60 ppm), the level should be checked weekly and adjusted as needed. The test for this is very simple. Basically a chemical is added to a sample of pool water and allowed to sit idle for a short time. If stabilizer is present in the pool, the sample should become cloudy. The degree of cloudiness thus determines the concentration with very cloudy water having a higher concentration. As with other tests discussed thus far, it is a simple test to conduct but can give erroneous results if the eight (8) testing rules are not followed.

POOL RECORDS

As stated earlier, records of daily testing are required by the Health Department. However, there are a number of other valuable reasons why records are important.

The most dramatic reason for keeping records is protection. In today's society, with lawsuits so commonplace, an operator must protect himself or herself in case an accident does occur. A patron will not hesitate to sue the owner, the operator or anyone else if the opportunity presents itself. If there is not proper documentation to refute claims of negligence, the patron will probably win. One such case involved a claim that the water was too cloudy and when a patron dove into the pool, he hit someone and was injured. Subpoenaed records clearly stated that the water clarity was excellent that day and the case was dismissed.

There are other reasons why records should be kept. Records, over a period of time, may give an indication of problems, either chemical or mechanical. For example, a gradual increase in pressure in the filter may indicate a need for new sand. Records can also track use of chemicals, reagents, etc., and indicate a need for the purchase of new or additional materials.

Finally, pool records are an aid in daily operation and assist operators and lifeguards, at the shift changes, in knowing what has been going on with the pool, what has been done and what remains to be done. As you can see, there are a lot of reasons why records should be kept. Now the question is "What types of pool records should be maintained?"

When it comes to keeping pool records, there is no such thing as too much information. Among the things which should be kept are:

1. Free chlorine residual or the equivalent, must be taken at the time of the pool opening, and every two (2) hours thereafter until the pool is closed for the day.
2. pH tests must be taken every 2 hours.
3. Number of pool patrons for the day.
4. Weather factors, temperature, degree of cloud cover, wind velocity and any other factors which might affect wither number of patrons or pool chemistry.
5. Pool recirculation flow meter readings at opening and at closing times and before and after any changes in filter operation.
6. Amount of new water added, and the reason it was necessary.
7. Water temperature at opening and closing times.
8. Recirculation pump stoppage with an explanation of the reason. Record how long it was stopped.
9. Amount of disinfectant added (i.e. chlorine).
10. Amount of any other chemical added (i.e. soda ash, acid, etc.).
    NOTE: Always follow manufacturer's instructions when mixing chemicals with water, and **never** add water to a container of acid or base. Instead, add the acid or base to the container of water.
11. Pool cleaning operations done (i.e. vacuuming, bottom brushing or other).
12. Water clarity must be at a level that:
    a. The main drain of the pool can be easily seen at all times from the pool deck.
13. Filter backwashing operations (pressure gauge reading before and after).
14. All other incidences worthy of note, such as equipment breakdowns, accidents, special pool operation procedures and development of possible hazards to patrons.
15. Results of bacteriological water tests.
16. Delivery of all supplies and chemicals, including volume or number of containers.
17. Any deviation from normal cleaning maintenance and/or operation routines.

Also worthy to note, but possibly in a separate log, are the following items:

1. Depletion of pool supplies or chemicals to pre-determined level.
2. Use of spare parts normally kept on hand.
3. Record of all routine equipment inspections and any special notes on the condition of the equipment at the time of inspection.

Weekly, monthly, or seasonal maintenance schedules should be drawn up and posted as permanent records to ensure timely performance of such operations as filling bearing grease cups on pumps, operating seldom used valves, etc. Performance of these duties should be noted in both the daily log and the maintenance schedules.

When a problem in operation develops, a review of the daily operation records may often allow the pool operator to pinpoint the cause and save considerable time and expense in the trial and error methods for correction.

One injury case involved a young boy who dove into the water and struck the bottom. The plaintiff admitted that depth signs were prominent, but claimed that the pool was not filled to the stated depth at the time of the accident. The daily pool records showed that the pool had been filled to overflowing only a few hours prior to the accident to allow a skimming action through the overflow trough. A judgment was returned in favor of the pool owner. One such legal judgment makes years of tedious record keeping very worthwhile!

A permanent record of the design of the pool should be kept in an easily accessible place. Periodic evaluation of equipment, or the changeover from one pool operator to another, requires such permanent information as pool dimensions, pool capacity, filter size and rate of flow for which the pump and filters were designed.

The rate of turnover, pump capacity and the average and highest head developed during a filter run are also important to have recorded. It is also helpful to have the name of the manufacturer, the model and serial number of all equipment and the addresses of all the suppliers from whom the equipment was bought.

Samples of various forms follow this page. Among the factors included are copies of a daily log/record sheet, a filter from placard, and a sample form for posting daily water quality standards. You may use these at your pool and additional copies are available through the Portsmouth Health Department.

Chapter 6

Maintenance and Seasonal Care

POOL MAINTENANCE AND SEASONAL CARE

Pool patrons will be judging you and the pool facility based on the way the pool looks and smells. The average bather knows very little about pool chemistry or the bacteriological science of water quality. Most people are looking for crystal clear water that doesn't burn their eyes and smell funny. So remember that because bacteria and viruses are microscopic, clear water doesn't necessarily mean that the pool is sanitary.

The end of the operating season is the best time to inventory your equipment, prioritize and complete repairs, and prepare your facility for winter weather. Each operator should carefully review the inspection reports from your health department specialist and make a list of problems that need to be corrected. Major repairs should be prioritized and most importantly budgeted for. You may call and ask for a preseason inspection from your health inspector to help with decisions on major repairs to pool shell, pump/filter equipment replacement, etc. Sometimes we have a copy of the plans for your pool/equipment and will need to insure what you may be purchasing will meet the requirements of our regulations before you spend the time/money to make repairs. Remember, just because you did not do these things at season's end, or maybe you did not even work for this pool facility, now that you are ready to open your pool, or perhaps you have already opened your pool and need to get off to a good start, it is your responsibility to determine what needs to be done.

I. WINTERIZATION

COVER POOL- as soon as you officially close POST SIGNS – no trespassing.

CHECK AND CLEAN SAND – filters: RAPID SAND or HIGH RATE – leave cover off filter but cover with screening to exclude insects, etc.

CHLORINATORS –flush with clean water, drained, and store indoors. Change tubing if dry rotted, use chemical tubing – wrong type will dissolve plastic, gum-up and blow up!!! Use excess chlorine to superchlorinate pool during winter prevents algae growth, etc. Return chlorine gas cylinders – do not store excessive chemicals over the winter.

REAGENTS – Dump out all test kit reagents or store in a refrigerator. Put on re-order list.

VALVES – operate all valves at full range before winterizing and throughout the season to prevent sealing up.

DRAINS – Leave drains, filter valves and recirculation line valves half open – except MAIN DRAIN!!!!!!!

PUMP – drain and apply grease as necessary.

All moving parts requiring lubrication should be oiled or greased, and petroleum should be applied to any metal surfaces requiring protection from corrosion. DO NOT put oil/grease on any part of a system which might come in contact with gas chlorine or dry hypochlorite – HIGHLY REACTIVE.

II. OTHER

DECK FURNITURE – Store all deck furniture inside to prevent damage or vandalism.

POOL LADDERS – Remove pool ladders, lifeguard chairs, and diving boards and store inside.

DRINKING FOUNTAINS – Drain and cover to prevent staining.

LIGHTING – Remove floodlight bulbs and reflectors should be removed with the sockets plugged. (reflectors may be coated with a clear oil to protect against rusting)

SERVICE BUILDINGS:
Water supply – turn off at service point and drain all fixtures. Partially fill toilets with antifreeze to prevent ice expansion damage.
Electrical Service – cut off at panel.
Gas supply – for pool heaters, turn off and drain all heater pipes. Thermostat circuit breakers should be left open. .

III. PREOPENING – SPRING!!! This is defined as the period while the pool is close the gate is locked, your "POOL CLOSED" sign is still posted, and you are preparing for opening day. This is the hard part! The effort you put forth during this period will really help you to sit back and let your equipment do the work for you the rest of the summer.

REMOVE COVER – Clean and dry cover, store in dry secure place. If pool is not covered for winter, you may have to work harder to condition water for opening day.

CLEAN POOL SIDES – If it is drained, check hydrostatic relief valves in pool paint/resurface pool shell if needed. Check steps – best time to repair is when the pool is drained. Otherwise, elbow grease is what's required to remove staining, algae, etc.

FILL POOL – City water-permission must be granted (in some localities), well water – bacteriological sample first. May take several days to refill pool – plan ahead.

INSPECT DECK – Repair cracks, holes, clean out grass – hot water vs. herbicide. Deck is to be smooth/recaulk coping. Replace grease tiles and depth markers – required at all pool and sand edges of wooden decking.

FENCING – Repair as needed – look for cracks/slots between boards, gate must be self-closing and lock must be available.

BRUSH – Trim poison ivy, check landscaping for debris.

FILL SPOUT – Adjust as needed – 2" above coping. Replacing with a quick disconnect-type fitting is recommended to reduce trip hazard. Paint with bright paint.

DIVING BOARD – Reinstall; replace bolts as needed.

SLIDE – Clean and check for stability.

JUNCTION BOX – Repair where rusted/paint to be rustproof or replace box with weather type cover. Cover with chair if it is a trip hazard but do not jeopardize bathers.

DRAINAGE – Landscaping, building guttering, building (decks, etc.) directed away from pool!

SIGNS – Post signs as necessary:

REMEMBER: WHERE CONTROL OF PATRONS BEGINS – Good signage with lettering a minimum of 4 inches in height

1. Pool rules- near entrance
2. Spa rules- near entrance
3. Directions to pool – for emergency vehicles
4. Vertical and horizontal depth markers
5. No diving
6. Maximum capacity
7. No Lifeguard on duty (if needed)

HOSES – In good repair and hung in proper places

LIFESAVING EQUIPMENT – Inspect each item; replace throw line (150lb. line)

DAILY OPERATING/MAINTENANCE ITEMS

REMEMBER: Keep the gate locked – don't be tempted to open the gate to sun bathers until the pool is officially open! Liability!

VACUUM/BRUSH POOL WALLS AND BOTTOM

BACKWASH FILTER IF NECESSARY

SWEEP OR HOSE OFF POOL DECK

CLEAN SKIMMER BASKETS

CLEAN GREASE LINE FROM POOL WALL TILES

TEST POOL WATER AND RECORD FORMS

MAKE NECESSARY CHEMICAL ADJUSTMENTS

CLEAN RESTROOMS AND RE-STOCK TOILETRIES

KEEP FLOOR DRY AND CLEAN

USE DISINFECTANT ON TOILETS, SINKS AND FLOOR SURFACES

CLEAN HAIR AND LINT STRAINERS

PUMP ROOM –Keep door locked

1. Do not prop door open – keep shut
2. Keep path clear
3. Chemicals off floor and dry
4. Properly labeled
5. Floor dry, neat and organized
6. Stock toiletries
7. Cleansers
8. Store test kit when not in use

**NO NON-POOL ITEMS – no paint, oil, gasoline, lawnmowers

9. Well-lighted/shielded lights
10. Keys to office for telephone should be accessible
11. Check flow meters – clean and replace

IV. OPENING DAY - COMPLETION OF PRE–OPENING TASKS

LIFESAVING EQUIPMENT
Put in proper location in pool area:

- Ring buoy
- Shepherd's crook or pole
- Backboard

LIFELINE
Insure there are sufficient buoys;
Install between deep and shallow ends at breakpoint

FIRST – AID KIT
Insure it is properly stocked with:
Band-aids, gauze and tape,
Scissors, first aid cream

TEST KIT
Clean and stock with fresh reagents

RECORD BOOK - Stock with record forms for chemical levels, accident reports, etc.

DIRECT-DIAL TELEPHONE
Insure it is accessible and in working order

TRASH CANS
As many as needed

LIFEGUARD STAND
In place and centrally located

POOL RULES AND REGULATIONS

CHEMICAL LEVELS POSTING PLACARD
Insure they are in plain view of patrons

A complete pre-opening pool/spa checklist can be obtained from the Portsmouth Health Department web page at http://www.vdh.state.va.us/LHD/portsmouth/AppForms.htm

Chapter 7

Portsmouth City Pool Code

ARTICLE I. - IN GENERAL

Sec. 34-1. - Title.

This chapter shall be known and cited as the "Portsmouth Swimming Pool Ordinance."

(Code 1988, § 34-1; Ord. No. 1996-40, 6-25-1996)

Sec. 34-2. - Scope.

(a) The Virginia Board of Health Swimming Pool Regulations and the Virginia Uniform Statewide Building Code, as amended, including all future amendments thereto and editions thereof, and all model building codes and portions of other model codes or standards which are, or may hereinafter be, referenced, adopted or incorporated therein, are hereby adopted and incorporated by reference into this chapter.

(b) The provisions of this chapter shall apply to all public swimming pools as indicated and defined in section 34-3, including, but not limited to, commercial pools, public or private school pools, gymnasium pools and health establishment pools. Public swimming pools for which building permits are issued subsequent to the effective date of this chapter shall be constructed in accordance with provisions of the Virginia Uniform Statewide Building Code, fire prevention code, the zoning ordinance and this chapter. The administrative authority or authorized agent shall order reasonable changes in any public pool or related facility or in its operation if he finds any conditions that endanger the life, health or safety of the users of such public swimming pools. In considering whether to order such changes, the administrative authority shall consider the magnitude of the danger, cost of the changes required, and the requirements imposed by this chapter upon newly constructed public swimming pools.

(c) Private swimming pools shall be constructed in accordance with the provisions of the Virginia Uniform Statewide Building Code and the zoning ordinance.

(d) The provisions of the chapter shall apply to all auxiliary structures and equipment provided and maintained in connection with public pools, including, but not limited to:

(1) Locker rooms.
(2) Shower rooms.
(3) Dressing rooms.
(4) Disinfecting equipment.
(5) Safety equipment.

(Code 1988, § 34-2; Ord. No. 1996-40, 6-25-1996)

Sec. 34-3. - Definitions.

The following definitions shall apply in the interpretation and the enforcement of this chapter. The word "shall" as used herein, indicates a mandatory requirement:

Administrative authority means the director of public health or his authorized agent.

Hydrostatic relief valve means a valve which, when properly installed will relieve underground water pressure caused by high water table under the pool shell.

Maximum load means the number of bathers permitted in the pool area, to be determined by dividing the total water surface area in square feet (or square meters) of the swimming, spa or wading pool water space by 27 feet (8.18 meters).

Operator or *manager* means the person appointed or engaged to conduct the operation and management of the swimming facility.

Operator's certificate means a certificate that proves competency in pool operation issued by a source approved by the administrative authority.

Owner means the person in whose name the license or use permit is issued.

Pool management company means any person, firm, corporation or association contracting to manage or operate two or more public swimming pools.

Pool permit means a permit issued to the facility by the administrative authority to allow for the operation of the public pool.

Private swimming pool means any structure that contains water over 24 inches (610 mm) in depth and which is used, or intended to be used, for swimming or recreational bathing only by the family and guests of the resident in connection with a residential occupancy classified as Use Group R-3 under the Virginia Uniform Statewide Building Code. This includes residential in-ground, aboveground and on-ground swimming pools, hot tubs and spas.

Public pool or *public swimming pool* means any pool, other than a private swimming pool.

Spa and hot tubs means public pools designed for recreational or quasi-therapeutic use for physiological and psychological relaxation that include but are not limited to: Hydrojet circulation, hot water, cold water, mineral baths, air induction systems or any combination of these.

Wading pool means a pool designed for wading or partial immersion of the human body which is capable of impounding water to a depth not greater than 24 inches (0.6 meter) and which is separate from any other pool within the facility.

Water slides/rides means a combination of pools and immersion troughs carrying water from pool to pool.

(Code 1988, § 34-3; Ord. No. 1996-40, 6-25-1996)

Sec. 34-4. - Plans, construction and inspection.

(a) A person proposing to construct, reconstruct or alter a public swimming pool or auxiliary structure or equipment shall submit legible plans and specifications to the administrative authority for review and written approval prior to the issuance of any building, plumbing or electrical permit.

(b) The administrative authority may require the submission of such additional information as may be required to determine the compliance of plans and specifications submitted for approval.

(c) Within ten days of the receipt of final plans and specifications, the administrative authority shall notify the person submitting the plans and specifications of their approval or disapproval. In addition to these regulations, all applicable ordinances, including, but not limited to, plumbing, building, electrical and zoning shall also apply in the construction, maintenance and operation of all public swimming pools.

(Code 1988, § 34-4; Ord. No. 1996-40, 6-25-1996)

Sec. 34-5. - Permit required; fee.

(a) No person shall operate a public swimming pool unless an annual permit has been secured from the administrative authority of the health department. This permit shall be issued only after approval by the administrative authority, approval by the electrical and plumbing official, application and payment to the health department of a fee as set forth in appendix A to this Code for seasonal operation (four months or less) and a fee as set forth in appendix A to this Code for year round operation. The operation and maintenance of any public swimming pool in a manner not in accordance with the provisions of this chapter will be justification for cancellation of this permit.

(b) A public swimming pool permit shall be posted in view of the public at the swimming pool involved.

(c) No public swimming pool permit shall be transferable and any person holding such a permit shall give notice in writing, to the administrative authority within 24 hours after having sold, transferred, given away or otherwise disposed of his interest in or control of the pool involved. Such notice shall include the name and address of the person succeeding to the ownership or control of such pool.

(Code 1988, § 34-5; Ord. No. 1996-40, 6-25-1996)

Sec. 34-6. - Inspections.

(a) The administrative authority shall have the power to enter, at reasonable times, upon any private property for the purpose of inspecting and investigating conditions relating to the enforcement of

this chapter or regulations adopted pursuant thereto.

(b) In addition to the inspections required by the department of planning, division of permits and inspections, all piping and appurtenances included in the recirculation and filter system shall be inspected prior to covering. All piping shall be tested at the time of inspection pursuant to the Virginia Uniform Statewide Building Code.

(Code 1988, § 34-6; Ord. No. 1996-40, 6-25-1996)

Sec. 34-7. - Owner's certification.

(a) To secure a pool permit, each public pool shall have a person employed who holds a valid operator's certificate issued by a source approved by the administrative authority. Operator's certificate shall be issued only to an individual over the age of 16 years. An applicant for an operator's certificate shall demonstrate basic knowledge of the water treatment process in public swimming pools. Presentation of a certificate from a swimming pool operators' training course acceptable to the administrative authority shall constitute demonstration of such knowledge.

(b) Every public pool shall have a person on premises at all times during periods of operation, who is fully capable of and shall assume responsibility for compliance with all requirements relating to pool operation, maintenance and safety of bathers.

(c) Routine (e.g., daily and weekly) operating procedures shall be permanently posted in a location accessible to and frequented by the operator.

(d) Manufacturer's instructions for operation and maintenance of mechanical and electrical equipment shall be kept available for the operator.

(e) No public pools shall be used or available for use until all requirements of section 34-5 and this section are complied with.

(Code 1988, § 34-7; Ord. No. 1996-40, 6-25-1996)

Sec. 34-8. - Suspension of public pool permit.

(a) If the administrative authority finds that the health and safety of those who utilize a public swimming pool is endangered, due to improper operation or continued for flagrant violation, he may order the immediate suspension of the pool's permit until such time as he finds that the danger no longer exists. No person shall operate any public swimming pool when subject to an order of suspension.

(b) The administrative authority shall notify the owner, in writing, stating the reason for the suspension. The owner shall have the right to appeal the suspension to the administrative authority. However, such appeal shall not affect the order for suspension until such time that the appeal is heard and the order changed. The owner may request a reinspection when the condition causing the suspension has been corrected. Upon compliance with the requirements of this

chapter, the suspension shall be removed.

(c) Any person aggrieved by the refusal to grant, or by the revocation or suspension of the permit of a swimming pool, shall have the right to appeal therefrom to the circuit court of the city after an administrative hearing.

(Code 1988, § 34-8; Ord. No. 1996-40, 6-25-1996)

Sec. 34-9. - Violations of provisions governing prosecutions, notice, etc.

The provisions of Volume I of the Virginia Uniform Statewide Building Code shall govern the prosecution of violations relating to the design and construction of swimming pools and installation of related equipment. A violation of any other provision of this chapter shall constitute a class 3 misdemeanor and every failure, refusal or neglect to fully and completely comply with the provisions of this chapter and each day's continuance thereof beyond the time specified shall constitute a separate offense.

(Code 1988, § 34-9; Ord. No. 1996-40, 6-25-1996)

Sec. 34-10. - Pool management companies; duties.

All pool management companies, within ten days after commencing operation of a public pool, shall provide the administrative authority with the names and locations of all public pools they operate in the city and the names, telephone numbers and addresses of their operating personnel. Such companies shall be responsible for assuring compliance with sections 34-5 and 34-7 of this chapter.

(Code 1988, § 34-10; Ord. No. 1996-40, 6-25-1996)

Sec. 34-11. - Applicability of chapter to existing pools.

The structural and equipment provisions and requirements of this chapter shall not apply to any public pool constructed prior to the effective date of this chapter, except as follows:

(1) Any alteration, placement or replacement of any equipment shall comply with such requirements.
(2) The provisions and requirements of this chapter with respect to operational procedures and standards, chemical feeding equipment, flow meters, pressure gauges and lifeguards shall be complied with by all public swimming pools, regardless of date of construction.
(3) The administrative authority may grant modifications to any of the provisions of this chapter which are not under the jurisdiction of the Virginia Uniform Statewide Building Code.

(Code 1988, § 34-11; Ord. No. 1996-40, 6-25-1996)

Sec. 34-12. - Severability clause.

Should any article, section, subsection, sentence, clause or phrase of this chapter be declared invalid by a court of competent jurisdiction, such decision shall not affect the validity of the chapter in its entirety or of any part thereof other than that so declared to be invalid.

(Code 1988, § 34-12; Ord. No. 1996-40, 6-25-1996)

Secs. 34-13—34-25. - Reserved.

ARTICLE II. - DESIGN AND CONSTRUCTION

Sec. 34-26. - Location.

The location of a swimming pool shall be in accordance with the provisions of the Virginia Uniform Statewide Building Code.

(Code 1988, § 34-26; Ord. No. 1996-40, 6-25-1996)

Sec. 34-27. - Shape.

Pools may be of any dimension or shape; provided that satisfactory recirculation of water can be obtained and undue hazards to bathers are absent.

(Code 1988, § 34-27; Ord. No. 1996-40, 6-25-1996)

Sec. 34-28. - Recirculation systems.

(a) *Filter room.* Public pools shall be provided with a structure or room to contain the filtration equipment, pumps and other recirculation system appurtenances, and disinfection equipment. The room shall be finished in a light color and be constructed of materials which are impervious to water and chemicals necessary for the operation of the pool. Adequate illumination of 20 footcandles measured 24 inches (61 centimeters) above floor level, shall be provided by a minimum of two vaporproof lighting fixtures. The floor of the filter room shall be designed to provide for an adequate drainage with a minimum floor slope of 1:50 and a maximum of 1:24 to the drain and shall be kept dry, particularly in the vicinity of electrical panels. The filter room shall be adequately cross-ventilated and all equipment shall be installed so that it is convenient to operate and repair. Adequate headroom shall be provided above all filters. The provision of any facility for discharging filter backwashing water into the filter room floor is prohibited. The room shall be provided with a door of sufficient width to permit the removal of equipment, and shall be capable of being secured against entry by unauthorized persons. The entrance to the filter room shall be adjacent to the pool area or so located that the operator can enter the room without having to exit the enclosed pool area.

(b) *Filters.* The recirculation system shall be equipped with a filtration system that will filter the entire contents of the pool at the required rate. Filtration equipment shall be operated continuously 24 hours per day. Design criteria for the indicated type of filters shall be as follows:

(1) *Rapid sand filter.* A filter utilizing sand as the filter media, with filtration flow rate not exceeding three gallons per minute per square foot (122 liters per minute per square meter) of filter area. The backwash rate of flow shall be three times the filtration rate.

(2) *Anthracite filter.* A filter utilizing anthracite as a filter media, with filtration flow rate not exceeding three gallons per minute per square foot (122 liters per minute per square meter) of filter area. The backwash rate of flow shall be three times the filtration rate.

(3) *High rate filter.* A filter utilizing a media capable of filtration at a high rate of flow. The rate of flow shall be greater than five gallons per minute per square foot (203.7 liters per minute per square meter) of filter area. The backwash rate of flow shall be the same as filtration rate.

(4) *Diatomaceous earth filter.* A filter utilizing diatomaceous earth as a filter media. There are two types of these filters.

a. *Pressure or vacuum-type.* A diatomaceous earth filter through which the rate of flow does not exceed two gallons per minute per square foot (81.5 liters per minute per square meter).

b. *Pressure or vacuum-type with slurry feeder.* A filter equipped to continuously feed a diatomaceous earth suspension and having a rate of flow not exceed three gallons per minute per square foot (122 liters per minute per square meter).

A backwash sump pit with a stand pipe shall be installed to collect spent diatomaceous earth so that it can be collected and disposed of with solid waste. Any other method for accomplishing this may be submitted for consideration. Other filtration systems which are equal to or better than those described above may be used in a pool recirculation system with the approval of the administrative authority.

(c) *Gauges.* Gauges shall be installed as required, on all filter systems to readily indicate the operating pressures of recirculating systems. All gauges shall measure pressure directly in pounds per square inch or kilograms per square meter and shall have an indicator at least two inches (5.08 centimeters) in diameter.

(d) *Rate of flow indicators.* The recirculating system shall be equipped with a rate of flow indicator, which has been approved by the administrative authority. The indicator shall read in gallons per minute or liters per minute and shall be located to indicate the rate of flow of filtered water being returned to the pool. The indicator shall be of fixed calibration and properly sized so as to indicate the designed rate of flow at approximately midscale.

(e) *Hair and lint strainer.* At all installations where it is possible for water from the pool to pass through the filters, a strainer shall be provided on the suction side of the pump to prevent hair, lint and other matter from reaching the pump and filters. Strainers shall be corrosion-resistant with openings not over one-eighth inch in size providing a free flow area at least four times the area of the pump suction line at the strainer connection and shall be accessible for frequent cleaning.

(Code 1988, § 34-28; Ord. No. 1996-40, 6-25-1996)

Sec. 34-29. - Piping systems.

(a) The piping system for public pools shall be composed of N.S.F. approved materials or equal, designed for the following operations:

(1) Filling the pool;
(2) Washing each filter to waste;
(3) Recalculating the pool water through the treatment equipment;
(4) Backwashing to waste;
(5) Operating suction cleaner;
(6) Emptying the pool; and
(7) Draining the system.

(b) There shall be no direct connections between the pool recirculating system and the sewer or the potable water supply. Fill spouts may be located under diving boards, under guard chairs or adjacent to pool ladder handrails. Fill spouts shall be installed a minimum of two inches (5.08 centimeters) above the coping, or submersed fill spouts shall be equipped with a backflow preventer.

(c) Waste from backwashing shall be discharged into the sanitary sewer or in a manner approved by the administrative authority.

(d) The piping system within the filter room shall be securely anchored and shall be color coded as follows:

Freshwater—Blue (to check valve).

Backwash—Black.

Influent—Yellow.

Effluent—White.

Vacuum—Orange.

(e) All piping shall be designed to reduce friction losses to a minimum and to carry the required quantity of water at a maximum velocity not to exceed ten feet per second (3.05 meters per second) for discharge piping, except for copper wire where the velocity for piping should not exceed eight feet per second (2.44 meters per second). Suction velocity for all piping should not exceed six feet per second (1.83 meters per second). Design system head calculations shall be required to confirm the adequacy of proposed pipe sizing and pump selection.

(f) A permanent specification placard shall be conspicuously displayed on or adjacent to the filter and shall be properly lighted. Specifications, shall be printed or types and readily legible. The following information shall be included on the placard:

(1) Name and location of facility;
(2) Date of construction;

(3) Capacity in gallons (liters);
(4) Water surface area in square feet (square meters);
(5) Turnover rate in hours; and
(6) Rate of flow in gallons per minute (liters per minute).

(Code 1988, § 34-29; Ord. No. 1996-40, 6-25-1996)

Sec. 34-30. - Pool outlets.

(a) All pools shall have one or more main outlets in their deepest part for continuous removal of water for treatment and reuse or for emptying the pool. A main outlet shall be no less than 3.3 feet (1.14 meters) nor more than 19.7 feet (six meters) from another main outlet nor more than 16.4 feet (5.98 meters) from a pool wall.

(b) A main outlet opening shall be covered with a grating which is not hazardous to bathers, is secured in place, and is removable with tools. The grate opening area shall be large enough to have water entrance velocities not exceeding two feet per second (0.6 meter per second).

(Code 1988, § 34-30; Ord. No. 1996-40, 6-25-1996)

Sec. 34-31. - Operational safety.

(a) Pumps, filters and other mechanical and electrical equipment for public pools shall be enclosed in such a manner accessible only to authorized persons. Construction and drainage shall be such as to avoid the entrance and accumulation of water in the vicinity of the electrical equipment.

(b) The crossing of outdoor public swimming pools by overhead electrical conductors is prohibited.

(c) All metal barriers or railing on which a broken electrical conductor might fall shall be effectively grounded.

(d) All lighting fixtures shall be prohibited directly above the water surface except as permitted by the Virginia Uniform Statewide Building Code, and shall be protected in a manner which will prevent broken glass from falling on any surface within the pool area. All electrical switches and receptacles shall be of weatherproof construction and resistant to corrosion.

(e) Lights shall be prohibited directly above or within one meter horizontally of the pool rim in any indoor or covered swimming pool except as permitted in the Virginia Uniform Statewide Building Code.

(Code 1988, § 34-31; Ord. No. 1996-40, 6-25-1996)

Sec. 34-32. - Hydrostatic relief valve requirement.

In all in-ground pools, one or more hydrostatic relief valves shall be installed for the purpose of relieving the water pressure on the pool shell.

(Code 1988, § 34-32; Ord. No. 1996-40, 6-25-1996)

Sec. 34-33. - Pool lighting.

(a) Where public pools are to be used after dark, the swimming pool area shall be equipped with lighting fixtures of such number and design as to light all parts of the pool, the water therein, and the entire area. Fixtures should be installed in such a manner as to create no hazard to the bathers. The design and installation of the fixtures should be such that lifeguards can clearly see every part of the swimming pool, including decks, spring board and other appurtenances without being blinded by glare.

(b) Underwater lighting for such pools shall provide nine watts per square yard (8.2 watts per square meter) of water surfaces and shall require ground fault circuit interrupters (GFCI). (See Virginia Uniform Statewide Building Code.)

(Code 1988, § 34-33; Ord. No. 1996-40, 6-25-1996)

Sec. 34-34. - Decks.

All fill under decks shall be properly tamped and proper supports shall be provided to prevent decks from settling. Roof runoff or other drainage shall not be wasted onto the deck. All areas surrounding the deck shall have surface drainage directed away from the deck area.

(Code 1988, § 34-34; Ord. No. 1996-40, 6-25-1996)

Sec. 34-35. - Pool inlets.

Where inlets are in pool walls, such inlets shall be spaced not more than 19.7 feet (six meters) on center around the pool perimeter. Where inlets are in the pool bottom, the number of such inlets and location shall be so designed as to ensure the proper distribution of filtered water. All inlets, except freshwater inlets and wading pool inlets, shall be at least 15 inches (38.1 centimeters) below the overflow level of the pool except for prefabricated gutters with 45-degree angle inlets in the bottom. Each inlet shall be provided with a means of adjusting flow through a range of at least 50 percent of its design capacity. The control shall be readily accessible.

(Code 1988, § 34-35; Ord. No. 1996-40, 6-25-1996)

Sec. 34-36. - Suction cleaner.

A suction cleaner shall be provided. Where a suction cleaner is operated by the recirculating pump, a device shall be provided for throttling the flow from the various pool outlet (main drain, skimmer, surge tank, etc.). The suction cleaner line shall be connected through a hair catcher. Portable vacuum cleaner units shall be provided with outlets near the pool for the discharge of effluent. Hydraulic jet type suction cleaners shall be permitted in lieu of the above where freshwater pressure is 30 psi (2.1 kilograms per centimeter^2) or greater and is provided with an approved backflow prevention or antisiphon device if connected to the public or private potable water supply.

(Code 1988, § 34-36; Ord. No. 1996-40, 6-25-1996)

Sec. 34-37. - Safety and rescue equipment; other safety features.

Every public swimming pool shall be equipped with the following aids to safety and rescue which shall be readily accessible at all times:

(1) One or more safety tubes or lightweight but strong poles with blunted ends, not less than 12 feet (four meters) in length.

(2) One or more throwing ring buoys of less than 15 inches (38 centimeters) in diameter having a 150 pound (68.4 kilogram) test line attached of sufficient length to reach twice the width of the pool, placed on racks at strategic points adjacent to the pool.

(3) A lifeline shall be provided at the break in grade between the shallow and deep portions of the swimming pool, or six inches (15.2 centimeters) of either shallow side of the break with its position marked with visible floats at not greater than seven-foot (2.10 meter) intervals. The lifeline shall be securely fastened to wall anchors or corrosion-resistant materials and of a type which shall be recessed or have no projection which shall constitute a hazard when the line is removed. The line shall be of sufficient size and strength to offer a good handhold and support loads normally imposed by bathers.

(4) A readily-accessible room or area designated and equipped for emergency care of casualties. Minimum equipment shall be an approved first aid kit and a backboard meeting Red Cross standards.

(5) A direct-dial telephone with numbers for police, fire and rescue shall be readily accessible at all times.

(6) Approved signs shall be maintained in a legible manner as follows:
   a. Occupant load signs. A sign with clearly legible letters, not less than four inches (10.2 centimeters) high shall be posted in a conspicuous place near the main entrance to a pool which shall indicate the number of occupants permitted for each pool.
   b. Spa/hot tub pool. The occupant capacity of a spa/hot tub pool shall be based on one bather for every ten square feet (1.9 meters^2) of pool water surface area.
   c. The occupant capacity of all other pools shall be based on one bather for every 27 square feet (2.50 meters^2) of pool water surface area. Exception: Occupant capacity requirements do not apply to wading pools.
   d. Permanent and conspicuous signs shall be posted indicating the most direct route to the pool.

(7) In areas so indicated, signs with clearly legible letters not less than four inches (10.2 centimeters) high shall be posted in a conspicuous place and shall state "NO DIVING ALLOWED."

(8) Warning signs for pools using gas chlorine. Pools at which gas chlorine is used for disinfection shall have a conspicuously posted sign on the exterior side of the entry door to the chlorine room, or on the adjacent wall area. In addition to displaying the appropriate hazard identification symbol for gas chlorine, the sign shall state with clearly legible letters not less than four inches (10.16 centimeters) high, "DANGER: GASEOUS OXIDIZER-CHLORINE."

(9) Spa/hot tub warning signs. A precautionary sign with clearly legible letters shall be posted in a prominent place near the entrance to a spa pool which shall contain the following language:

"CAUTION"

a. Elderly persons, pregnant women, infants and those with health conditions requiring medical care should consult a physician before entering the spa.
b. Unsupervised use by children under the age of 14 is prohibited.
c. Hot water immersion while under the influence of alcohol, narcotics, drugs or medicines may lead to serious consequences and is not recommended.
d. Do not use alone.
e. Long exposure may result in nausea, dizziness or fainting.

(10) The depth of water in pools shall be marked at one-foot increments (30.48 centimeters) and at least every 20 feet (6.1 meters) on both the horizontal deck surface and vertical surfaces of the pool wall. Numerals and letters shall be at least four inches (10.16 centimeters) in height and have a good contrast with the pool walls and deck.

(11) Fixed and floating platforms in public swimming pools shall be constructed with an air space of at least one foot (0.3 meters) between the water surface and the underside of the platform.

(12) There shall be one elevated lifeguard chair provided for every public pool with a depth of over five feet (1.52 meters) or 2,000 square feet (202.99 meters^2) of water surface. An additional chair will be required for each additional 1,000 square feet (92.8 meters^2) of water surface.

(Code 1988, § 34-37; Ord. No. 1996-40, 6-25-1996)

Sec. 34-38. - Disinfection equipment.

(a) *Chemical feeding equipment.* Means shall be provided for regulating the feeding of chemicals to the water in the recirculation system. The installation and use of mechanical, automatically operated, positive displacement chemical feeders or dye type chemical feeders is required.

(b) *Chlorinating equipment.* All public pools shall be provided with approved chlorinating equipment which shall be capable of applying a dose of not less than ten ppm of chlorine within the turnover time.

(c) *Use of chlorine gas.* The use of chlorine gas as a disinfectant shall require the approval of the administrative authority. Such approval will be granted only after it has been demonstrated that the gas chlorinator room or area will be located in a manner which will not adversely affect the safety and health of patrons, pool personnel or the public. Chlorine gas feeding equipment and chlorine gas cylinders and other hazardous chemicals shall be installed in an enclosed space or room, separate from the filter room and electrical panels and shall be equipped with a door capable of being locked. The operating gas cylinder shall be placed on an accurate scale and fastened in place during storage and use. Gas chlorinator rooms shall be equipped with a forced draft fan exhausting to the outside room from the floor level. The exhaust fan shall be capable of providing 60 air changes per hour against the resistance offered by duct work or any other local factors. A fresh air inlet shall be provided near the ceiling. The gas chlorinator shall be protected from direct sunlight.

(d) *Gas masks.* An approved, self-contained gas mask for chlorine or a gas mask with a supply of oxygen under positive pressure or compressed air, either of which have been approved by the Bureau of Mines, in addition to local approval by the fire department, shall be provided where chlorine gas is being utilized. The mask shall be located accessible to, but outside of, the gas chlorinator room.

(Code 1988, § 34-38; Ord. No. 1996-40, 6-25-1996)

Sec. 34-39. - Water heating.

Indoor public pools shall be provided with water heating equipment thermostatically controlled and capable of maintaining the entire pool contents between 70 and 85 degrees Fahrenheit (21 degrees Celsius and 29.48 degrees Celsius). All heated pools, spas and hot tubs shall maintain a minimum halogen residual of 2.0 ppm or mg/l at all times. Spas and hot tubs shall have, on display, a clock and thermometer visible to occupants. Spas and pool water temperature shall not exceed 104 degrees Fahrenheit at any time that is occupied.

(Code 1988, § 34-39; Ord. No. 1996-40, 6-25-1996)

Sec. 34-40. - Showers, water closets, lavatories, etc.

(a) *Generally.* Showers, water closets and lavatories shall be provided for each sex, in accordance with the Virginia Uniform Statewide Building Code. The part of the structure containing the showers, water closets, urinals and lavatories shall be designed so that these facilities shall be in the line of travel used by the patrons prior to entering the pool area and shall be provided with an entrance and a separate exit opening directly to the pool deck; however, such exit shall not be near the deep portion of the pool.

(b) *Requirements.* Floor for all dressing rooms, showers, toilets and lavatories shall be smooth but must have nonslip finish and the room shall be ventilated so that the floors do not remain damp or wet. Walls and floors for all dressing rooms, toilet rooms and lavatories shall be of waterproof, easily cleanable materials.

(1) *Dressing rooms.* Separate dressing rooms may be provided for both sexes. When provided, metal lockers, wire baskets, hooks or other sanitary means of storage of clothing and personal accessories shall be provided. All storage containers for clothing shall be kept clean and sanitary.

(2) *Showers.* Showers shall be provided in the proportion of one for each 40 persons at the time of maximum load. Each shower shall supply an adequate quantity of tempered water. Water from each shower shall be provided with suitable facilities for making soap available.

(3) *Toilets.* Toilet facilities shall be provided as set forth in the Virginia Uniform Statewide Building Code.

(4) *Lavatories.* Lavatories shall be provided as set forth in the Virginia Uniform Statewide Building Code.

(5) *Exceptions.* Subsections (b)(1) through (b)(4) of this section shall not apply when bathers have access to these facilities either in living quarters located to more than 500 feet (152.4 meters) in travel distance from the pool, or in an adjacent building such as a recreational facility, clubhouse or cabana.

(6) *Mirrors.* Mirrors, if provided, shall be constructed in accordance with the Virginia Uniform Statewide Building Code.

(Code 1988, § 34-40; Ord. No. 1996-40, 6-25-1996)

Sec. 34-41. - Spectators/spectator areas.

Spectator areas shall be so separated from the pool area that spectators do not have access to the pool area. Spectator balconies shall not overhang any portion of the pool surface.

(Code 1988, § 34-41; Ord. No. 1996-40, 6-25-1996)

Sec. 34-42. - Wading pools.

(a) The slope of the bottom of any wading pool shall be no greater than 1:15 nor less than 1:40.

(b) Wading pools shall be so designed that no obstructions are within an area bounded by a line five feet (1.5 meters) outside of the pool perimeter.

(c) Wading pools shall be separated from the main pool by a suitable barrier with a self-closing and self-latching device.

(d) Wading pools shall be provided with their own water return line to provide an adequate flow of chlorinated water, or shall have a filter system completely separate from the main pool with a turnover of two hours or less.

(e) Wading pools shall be required to have a vacuum line.

(Code 1988, § 34-42)

Secs. 34-43—34-55. - Reserved.

ARTICLE III. - OPERATION

Sec. 34-56. - Conditions and equipment.

All equipment shall be maintained in satisfactory operating condition during operation of a public pool.

(Code 1988, § 34-56; Ord. No. 1996-40, 6-25-1996)

Sec. 34-57. - Water supply.

All public pools using well water shall have a satisfactory bacteriological sample taken prior to opening each year.

(Code 1988, § 34-57; Ord. No. 1996-40, 6-25-1996)

Sec. 34-58. - Clarity of water.

When a public pool is open and in use, the water shall be sufficiently clear to permit a disc six inches (15.24 centimeters) in diameter, divided into alternate black and white segments, and placed on the bottom of the pool at the deepest point, to be clearly visible from the pool deck at all distances up to ten yards (9.14 meters) in a horizontal direction from the projection of the disc on the pool surface. The disc shall be available on premises at all times or may be permanently affixed to the bottom of the pool in the deepest area.

(Code 1988, § 34-58; Ord. No. 1996-40, 6-25-1996)

Sec. 34-59. - Water treatment.

(a) Chemicals other than chlorine, bromine, hypobromous acid, sodium hypochlorite, calcium hypochlorite, muriatic acid, lime soda ash, sodium bicarbonate, aluminum sulfate (alum), cyanuric acid and sodium bisulfate shall not be used to treat swimming pool water without written permission from the administrative authority.

(b) The impounded water shall at all times be treated in a manner which will prevent the growth of algae and the breeding of mosquitoes or other vermin.

(c) When the unheated swimming pool is open for use, a minimum of one ppm (parts per million) free chlorine residual shall be maintained in all parts of the pool.

(d) When the swimming pool is open for use, the pH of the pool water shall be kept between 7.2 and 7.8 with a minimum total alkalinity of 80 ppm, calcium hardness of 150 ppm.

(e) Approved test kits for all tests required in this article shall be available and in good working condition at all times.

(f) The operator or manager of each public swimming pool shall maintain and operate all mechanical equipment in a safe and proper manner.

(g) Where cyanuric acid is used as a stabilizing agent for residual chlorine, or if the source of residual chlorine is from a chlorinated cyanurate, a chlorine residual of at least 1.5 ppm shall be maintained with cyanuric acid residuals of at least 40 ppm.

(h) The operator or manager of each swimming pool shall cause an adequate supply of chemicals for the proper treatment of pool water to be on hand and available for use at all times.

(i) Protective clothing, i.e., respirators, face masks, rubber gloves and aprons or coveralls shall be provided for personnel handling chlorine chemical compounds and other caustic chemicals.

(Code 1988, § 34-59; Ord. No. 1996-40, 6-25-1996)

Sec. 34-60. - Records.

(a) Record forms supplied by the administrative authority shall be maintained up-to-date and shall be available for inspection while the pool is in use and shall be retained for a period of at least four months, or for at least one year in the case of pools that operate year around.

(b) Unless otherwise modified by the administrative authority, disinfection tests, i.e., free chlorine residual and pH tests, shall be made and recorded at least once every two hours while the pool is in operation. Alkalinity and calcium hardness tests shall be made and recorded at least weekly.

(Code 1988, § 34-60; Ord. No. 1996-40, 6-25-1996)

Sec. 34-61. - Placards.

Placards approved by the administrative authority and covering personal health and safety regulations shall be posted within the swimming facility. Areas restricted to operating personnel shall be prominently identified. Signs warning employees of emergency procedures to be followed in case of exposure or contact with hazardous materials shall be posted in the room or area where such hazardous materials are stored and/or used.

(Code 1988, § 34-61; Ord. No. 1996-40, 6-25-1996)

Sec. 34-62. - Food and drink area.

Any person in the process of eating or drinking shall be restricted to the area designated for the preparation and serving of food and drink. This area shall be at least ten feet (3.05 meters) from the pool edge.

(Code 1988, § 34-62; Ord. No. 1996-40, 6-25-1996)

Sec. 34-63. - Cleaning and maintenance.

(a) *Generally.* All parts of the pool and related pool facilities and equipment shall be kept clean and maintained in good repair. Floors shall be kept free from cracks and other defects. Walls, ceilings, partitions, doors, lockers and similar surfaces and equipment shall be refinished in a manner acceptable to the administrative authority as often as necessary to be kept in good repair.

(b) *Hoses; sanitation.* Hoses shall be provided for regular flushing and cleaning. The whole pool area shall be kept clean, sanitary, and free of litter and vermin.

(c) *Plumbing fixtures.* Toilets, urinals, showers, wash basins and other plumbing fixture shall be maintained in a clean condition and in good repair.

(d) *General housekeeping and health spa facilities.* All floors, walls, ceilings, showers, bathtubs, saunas, steam and vapor rooms, cabinets, toilets, stalls and other physical facilities of the health spa must be in good repair and maintained in a clean and sanitary condition. All equipment and fixtures shall be thoroughly cleaned and effectively disinfected as often as needed to prevent the development of algae, fungi, mildew, mold or bacteria which may endanger the public safety or health.

(Code 1988, § 34-63; Ord. No. 1996-40, 6-25-1996)

Sec. 34-64. - Precautions relative to communicable diseases.

Any person having an obvious skin disease, nasal or ear discharge, inflamed eyes, or any communicable disease shall be excluded from the public swimming pool.

(Code 1988, § 34-64; Ord. No. 1996-40, 6-25-1996)

Sec. 34-65. - Public safety; security.

Public swimming pools shall be maintained in a manner which will not create a nuisance or hazard to the public safety and well-being when not in use, and the pool shall be adequately secured against entry by the public in general.

(Code 1988, § 34-65; Ord. No. 1996-40, 6-25-1996)

Sec. 34-66. - Lifeguards.

(a) There shall be at least one lifeguard on duty at all times when the public pool is of 2,000 square feet (185.79 meters^2) of water surface or more and when open for use.

(b) Public pools which are less than 2,000 square feet (185.79 meters^2) may be used by adults, or children supervised by adults, without a designated lifeguard, provided it is posted as follows: "WARNING: No lifeguard on duty. Children under the age of 14 shall not be allowed to use a pool without an adult in attendance."

(c) Any individual retained as a lifeguard for public pools of 2,000 square feet (185.79 meters^2) or more shall possess a current certification for meeting the standard of a lifesaver as recommended by the American Red Cross, YMCA or other accredited agency for lifesaving personnel.

(d) The ratio of lifeguards to bathers shall be one lifeguard on duty for the first 75 bathers and an additional lifeguard for every additional 50 bathers, or fraction thereof. Lifeguards shall wear distinguishing emblems or clothing while on duty.

(Code 1988, § 34-66; Ord. No. 1996-40, 6-25-1996)

Sec. 34-67. - Laundering.

Bathing suits, towels and other reusable cloth materials furnished by a public pool shall be properly laundered so as to be sanitary before being issued to bathers.

(Code 1988, § 34-67; Ord. No. 1996-40, 6-25-1996)

Sec. 34-68. - Animals.

Animals, fowl and/or pets shall not be permitted within the public swimming pool. This section shall not apply to working dogs, such as seeing-eye dogs.

(Code 1988, § 34-68; Ord. No. 1996-40, 6-25-1996)

Cross reference— *Animals, ch. 4.*

DARK AND/OR SLIPPERY SPOTS ON THE POOL OR SIDE WALLS OR DECK

Possible Cause	Remedy
-This is usually due to algae growth.	Sprinkle a few granules of calcium hypochlorite directly on the spots, but this may cause white spots on a painted or coloured liner bottom.

MILKY CLOUDINESS

Possible Cause	Remedy
1. In pools using diatomite filters, it is usually due to diatomaceous earth in the pool. Faulty precoat procedures or broken or torn elements are the usual cause.	1. Check and/or repair filter elements. Check and adjust precoat procedures.
2. In other pools, milky cloudiness is usually due to excess dirt load or to precipitation of calcium compounds.	2. Cloudiness should disappear with adequate chlorination and efficient filtration. Superchlorination will help if the cloudiness is due to organic dirt.
3. Very high total alkalinity.	3. Slug acid will lower alkalinity.

EYE IRRITATION

Possible Cause	Remedy
- Usually due to improper pH control or a build-up of combined chlorine compounds in the water due to insufficient chlorination.	Superchlorinate and maintain the pH constantly at 7.2 - 7.8. Maintain a free chlorine residual of 1.0 - 2.0 ppm.

GREEN HAIR

Possible Cause	Remedy
Results from copper ions in the water.	Discontinue use of copper base algaecides and maintain proper pH to prevent corrosion of copper pipes in the system.

LOW CHLORINE RESIDUAL

	Possible Cause	Remedy
1.	Rate of feed too low.	1. Boost rate of feed.
2.	Demand above normal due to heavy swimming load, hot sunny weather, algae, debris blows into pool - leaves, etc.	2. If chlorinator capacity is not sufficient, supplement chlorine feed by hand dosage of hypochlorites. Clear up algae.
3.	Chlorine "ice" may be formed due to high rate of feed from bottle or line clogged.	3. Feed from two bottles. Slope lines back to tank. Place lamp beside chlorinator.
4.	Corrosion or plugging of diffuser in chlorine injector assembly.	4. Shut off chlorine system and disassemble injector to clean diffuser.

TURBIDITY

	Possible Cause	Remedy
1.	Low recirculation rates.	1. Check flow meter, then the pumps and filters - backwash more often if filters are plugging.
2.	Poor filtration.	2. Inoperative slurry feeder. Tear in D.E. filter cloth, too little precoat. Channelling in sand filter.
3.	Underfeeding of alum (if used) pinpoint floc.	3. Increase feed.

4.	Algae growths.	4. Superchlorinate, use copper sulphate. Keep high free chlorine residual.
5.	Air leaks (fine bubbles in water).	5. Check piping.
6.	Wind-blow dust (dusty road nearby).	6. More vacuuming. Cover pool when closed. Increase turnover rate of pool.
7.	Precipitation of hardness due to addition of soda ash.	7. No remedy. Keep circulating. Control pH below 7.8.
8.	Iron in suspension.	8. (1) Add make-up water through filter. (2) Flush supply and make-up lines occasionally. (3) Add aluminum sulphate flocculent to enter pool surface at rate of 30 g. per 10 sq. m. of pool surface, and let settle.(Do not use aluminum sulphate with high rate fil ters). (4) Superchlorinate.
9.	Diatomaceous earth getting into pool.	9. Tear in filter cloth or broken element. Not enough recycle time in precoat. DE too fine for filter cloth.

ALGAE GROWTHS

	Possible Cause	Remedy
1.	Low chlorine residual.	1. Raise feed rate, supplement with hypochlorite.
2.	Hot sunny weather.	2. Maintain high chlorine residual.
3.	Pool temperature too high.	3. Keep below 26.7 C.

4.	Poor recirculation (dead spots in pool).	4. Check recirculation rates, hand hose corners and behind ladders with hypochlorite.
5.	Low wet spots on deck.	5. Eliminate, if possible, hand hose with hypochlorite and keep dry.
6.	Low pH (possible factor).	6. Raise pH by adding soda ash. (SLOWLY and continuously).

SHORT FILTER RUN (D.E. FILTER)

	Possible Cause	Remedy
1.	Algae growth.	1. Immediate superchlorination and maintaining a proper free chlorine residual may solve the problem.
2.	Poor precoat.	2. Use correct dosage and recycle during precoat. Replace filter cloth if plugged.
3.	No slurry feed.	3. Unplug or install slurry feed.
4.	Suntan and hair oils in pool water.	4. Require showers with soap and hot water.
5.	D.E. too fine.	5. Check recommended size.
6.	Prefeeding soda ash.	6. May cause bulky non-porous filter coating if not added slowly in dissolved form.
7.	Filter cloth or element clogged.	7. May require dismantling and acidizing elements.
8.	High turbidity.	8. Vacuum pool in morning. Patrons shower with soap and water. Check alkalinity.

SHORT FILTER RUN (SAND FILTERS)

	Possible Cause	Remedy
1.	Backwash rate too low or poor distribution of backwash water.	1. Check rate.

2.	Too high alum dosage.	2. Check and adjust feeders.
3.	Mud ball formation or growths in filter.	3. Chlorine residual too low, prechlorinate.
4.	Other causes as in D.E. filters, items 1, 4, 6 and 8 (above).	4. Remedies as in D.E. filters, items 1, 4, 6 and 8 (above).
5.	Air binding (due to too high negative pressure on gravity type).	5. Backwash.

LOW pH

Possible Cause	Remedy
Soda ash feeder plugged. Insufficient soda ash used. Abnormally high chlorine dosage.	Increase soda ash feed. Check amount added per day as well as feed rate

HIGH pH

	Possible Cause	Remedy
1.	High pH in make-up water.	Add muriatic acid
2.	Use of hypochlorites.	TAKE CARE IN HANDLING

pH DIFFICULT TO READ

	Possible Cause	Remedy
1.	High free chlorine dosage fades or changes colour produced in sample.	Add sodium thiosulphate to sample before running pH. Clean tubes thoroughly, rinse using pool water.
2.	Range of comparator is limited.	
3.	Tube is dirty.	

CLOGGING OF HYPOCHLORINATOR

Possible Cause	Remedy
1. Residue or precipitate clogging feed pump suction (particularly with hard water).	1. Syphon off and feed only clear liquid, using two containers. Add a few spoonfuls of calgon to the mixing tank.
2. Lines clog.	2. Clean or flush regularly.

CHLORINE RESIDUAL TOO HIGH

Possible Cause	Remedy
1. Chlorine demand has dropped - resulting in excess feed rate.	Turn off chlorinator.

ODORS

Possible Cause	Remedy
1. Combined chlorine residual too high.	Superchlorinate. Maintain free chlorine residual greater than 1.2 mg/l at pH of 7.5 and greater than 50% of the total residual.

SCALE BUILD-UP

Possible Cause	Remedy
1. Ph too high.	Obtain expert advice.
2. Hardness of water.	
3. High alkalinity.	

CORROSION PROBLEMS

Possible Cause	Remedy
1. pH too low.	1. Add soda ash, maintain pH level of 7.4 - 7.8.
2. Hardness too low.	2. Add calcium chloride dihydrate.

PUMP FAILURE

	Possible Cause	Remedy
1.	Air lock, air entering suction side of pump.	1. Prime pump, check pool water level for possible air entering skimmers, check hair and lint strainer for air leak.
2.	Plugged hair and lint strainer.	2. Clean hair and lint strainer.
3.	High resistance to water flow.	3. Backwash filter. Check hair and lint strainer, check for closed valves.

WHITE RING AROUND THE WATER LEVEL TILE

	Possible Cause	Remedy
1.	Calcium salts in hard water, high pH.	Lower pH with sodium bisulphate or muriatic acid. Maintain pH of 7.2 -7.8.

SCUM ON POOL WALLS AT WATER LEVEL

	Possible Cause	Remedy
1.	Inadequate skimming.	1. Check float wire, increase flow through skimmers. Scrub pool walls.
2.	Body oils and cosmetic lotions used by swimmers.	2. Shower with soap and warm water before entering pool. Recommend bathing caps be worn. Scrub pool walls.

SAND IN POOL

	Possible Cause	Remedy
1.	Failure of filter under drain system (collection manifolds).	1. Remove filter sand, check and replace under drains as necessary.
2.	Filter sand grain size inadequate.	2. Filter sand must meet the specifications of the manufacturer.

WHEN TO CLOSE THE POOL

1. Chemical Imbalance

If the pool water chemistry becomes imbalanced to a point that minor adjustments cannot correct it, and a significant amount of chemical must be added, it will be necessary to close the pool. The pool should remain closed until proper balance is restored.

2. Clarity

One of the most hazardous conditions that can arise in a swimming pool is poor water clarity. If the water becomes turbid to the point that the pool bottom or main drain cannot be seen, immediate closure is necessary. If you can not see the bottom of the pool or the main drain, you will not see a swimmer in trouble.

3. Mechanical Failure

If, for any reason, the pump(s), filter(s) or clorinators(s) malfunction and become inoperable and remain inoperable for greater than one hour the pool should be closed and a repair person should be called.

4. Electrical Outage/Failure

If power is lost and the circulation system ceases to function, the pool should be closed until power is restored and all equipment is again functioning properly.

5. Thunderstorm/Electrical Storm

If thunder is heard and a storm is threatening the pool should be closed until the storm has passed.

POOL/SPA OPERATORS WEEKLY REPORT

POOL NAME _____ ADDRESS _____
OPERATOR _____ DATES _____ TO _____

TIME		MON	TUES	WED	THUR	FRI	SAT	SUN
	CHLORINE							
	PH							
	CHLORINE							
	PH							
	CHLORINE							
	PH							
	CHLORINE							
	PH							
	CHLORINE							
	PH							
	CHLORINE							
	PH							

DAILY TASKS AND READINGS

BACKWASH							
HAIR STRAINER							
VACUUM POOL							
CHECK SKIMMERS							
ADD CHLORINE							
ADJUST pH (+/-)							
WATER TEMP.							
WATER CLARITY							
WEATHER							
COMMENTS							

WEEKLY TESTS AND READINGS

CYANURIC ACID	TOTAL ALKALINITY	CALCIUM HARDNESS
_____ppm	_____ppm	_____ppm

Produced and Distributed by TEHA Swimming Pool Conference

POOL SPECIFICATIONS PLACARD

POOL NAME_____ LOCATION_____

POOL PERIMETER:_____FEET
(2 X LENGTH+2 X WIDTH)

PUMP SIZE: _____HP _____FT.
HORSEPOWER HEAD

POOL AREA_____SQ. FT.
(LENGTH X WIDTH)

FILTER SIZE: _____SQ.

POOL CAPACITY:_____GALLONS
(AREA X AVG.DEPTH X 7.5)

FLOW RATE: _____GAL. PER MIN.

TURNOVER RATE: _____HOURS
(CAPACITY / FLOW RATE)

DESIGN POOL LOAD: _____
(POOL AREA / 27)

CONSTRUCTION DATE: _____

BACKWASH INSTRUCTIONS:_____

_____

_____

_____

BACKWASH WHEN: _____

IN AN EMERGENCY CALL: _____

ACCEPTABLE READINGS

CHLORINE 1-3 PPM BROMINE 2-4 PPM pH 7.2 -7.8 TOTAL ALKALINITY 80 - 120 PPM

CYANURIC ACID 40 - 60 PPM TEMPERATURE < 104°F CALCIUM HARDNESS 200 - 300 PPM

WATER QUALITY TEST RESULTS

FOR _____ AT: _____
DATE TIME

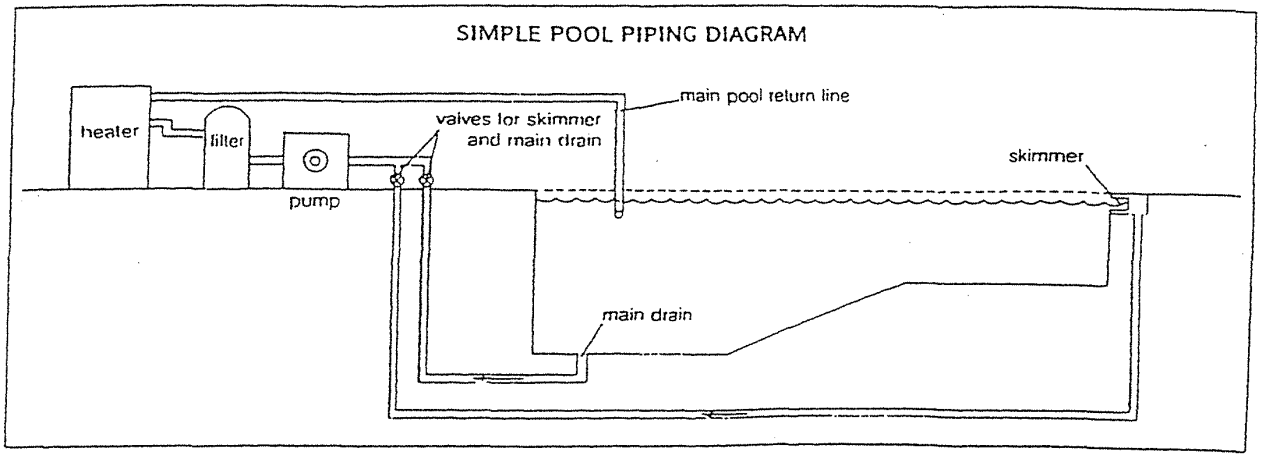
_____ _____ ppm
DISINFECTANT TYPE (chlorine, bromine, etc.) DISINFECTANT LEVEL

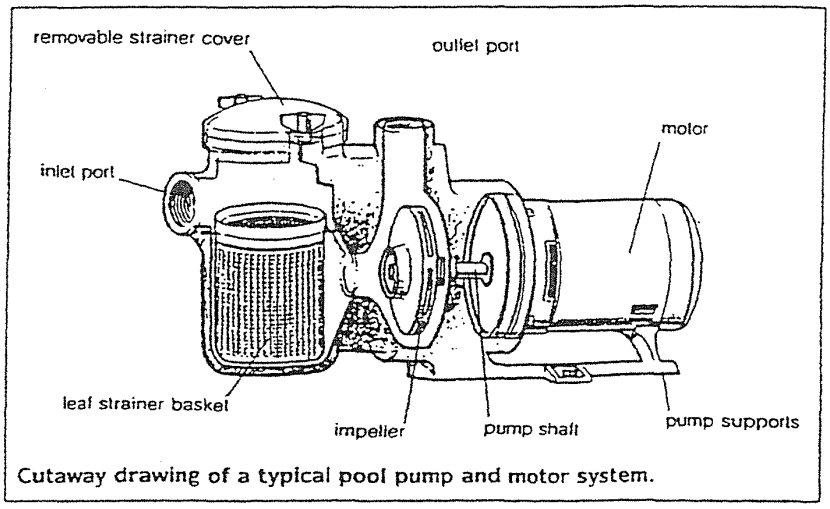
_____ _____ °F _____
pH TEMPERATURE OPERATOR

ACCEPTABLE LEVELS

POOLS			SPAS		
PARAMETER	MINIMUM	MAXIMUM	PARAMETER	MINIMUM	MAXIMUM
CHLORINE	1.0 ppm	3.0 ppm	CHLORINE	2.0 ppm	10.0 ppm
BROMINE	2.0 ppm	4.0 ppm	BROMINE	2.0 ppm	10.0 pm
pH	7.2	7.8	pH	7.2	7.8
TEMPERATURE	NONE 70 °F	104 °F (heated therapy pools) 85 °F (indoor heated pools)	TEMPERATURE	NONE	104 °F

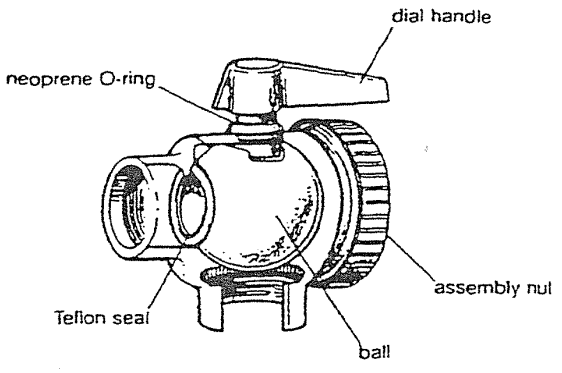
IF NOT WITHIN ACCEPTABLE LEVELS, PLEASE CALL THE HEALTH DEPARTMENT AT: _____





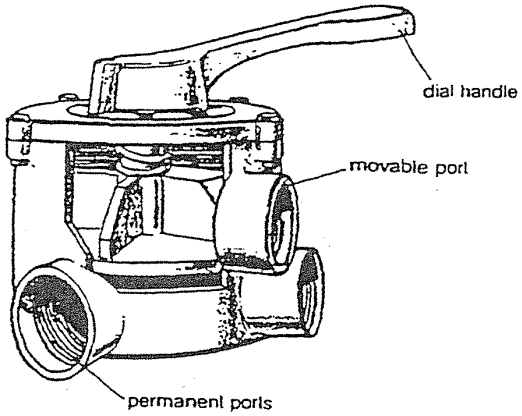
Cutaway drawing of a typical pool pump and motor system.

BALL VALVE

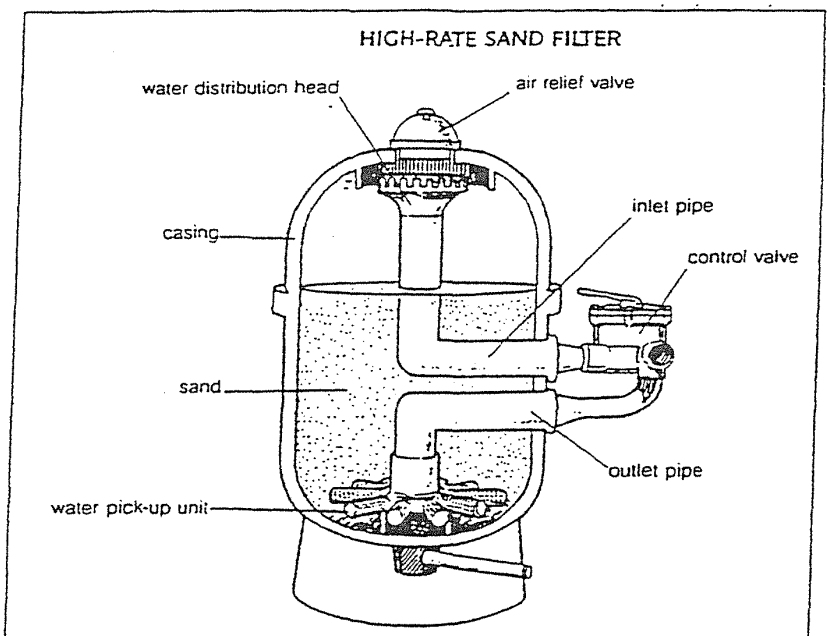


Used to control the force and direction of the water through the filter, ball valves offer two, three, and four flow variations.

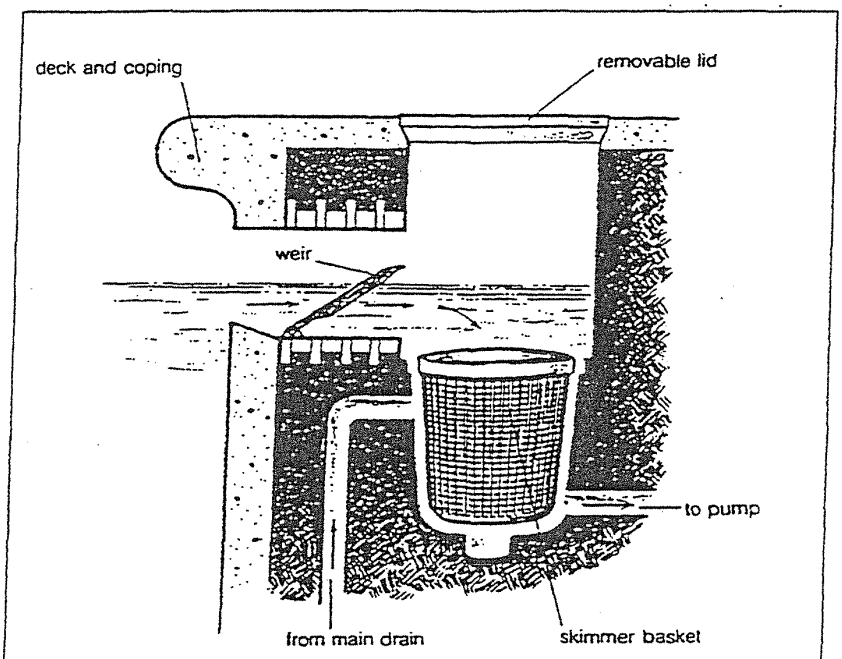
MULTIPORT VALVE



With a multiport valve you can choose as many as six different valve functions (such as backwash, filter, waste, closed) simply by engaging a single movable part.



Dirty pool water enters the high-rate sand filter through the inlet pipe, is sprayed onto the sand by the distribution head, is then purified by the sand, and pumped back to the pool clean of dirt and debris.



A pool skimmer is designed to collect leaves and other floating debris. This debris is retained in a skimmer basket to prevent it from passing into the filter system and obstructing the lines.

To Lower pH when it is too High, Add:
(In ounces of muriatic acid)

pH	Pool Size (gallons X 1,000)					
	5	10	15	20	25	30
7.4 - 7.6	-	-	-	-	-	-
7.6 - 7.8	6	12	18	24	32	36
7.8 - 8.0	8	16	24	32	40	48
8.0 - 8.4	12	24	36	48	60	72
over 8.4	16	32	48	64	80	96

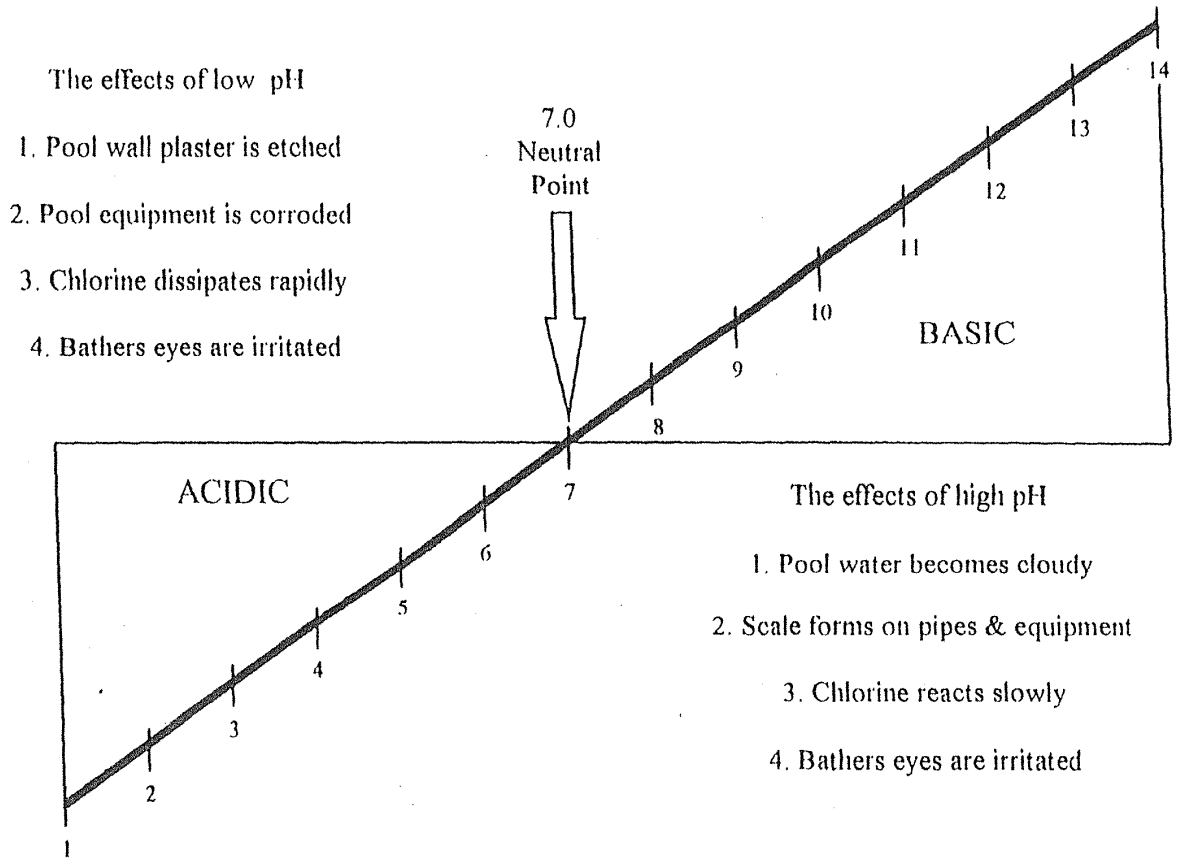
To Raise pH when it is too Low, Add:
(In ounces of soda ash)

pH	Pool Size (gallons X 1,000)					
	5	10	15	20	25	30
7.4 - 7.6	-	-	-	-	-	-
7.2 - 7.4	3	6	9	12	15	18
7.0 - 7.2	4	8	12	16	20	24
6.8 - 7.0	6	12	18	24	30	36
Below 6.7	8	16	24	32	40	48

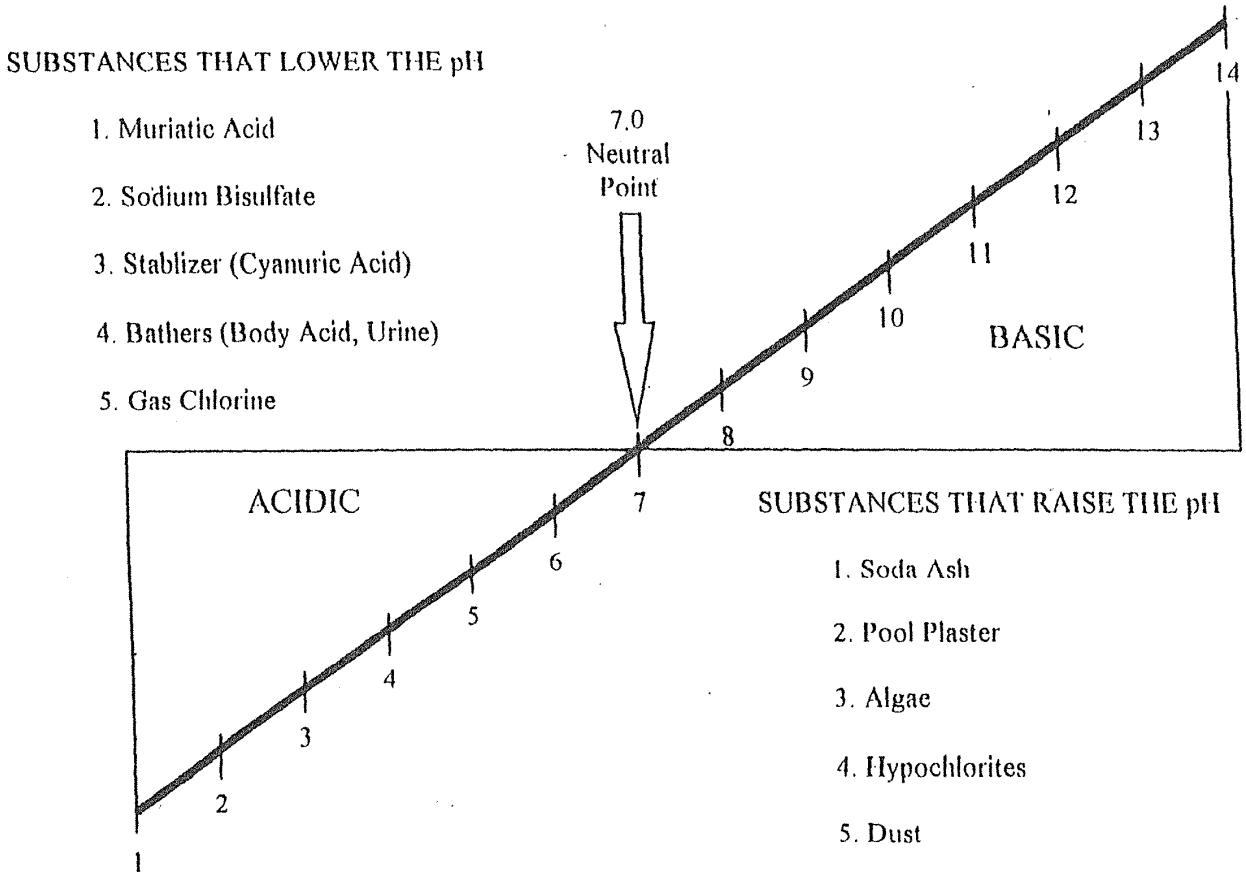
To Raise Calcium Hardness when it is too Low, Add:
(In pounds of calcium chloride)

Desired Increase (ppm)	Pool Size (gallons X 1,000)					
	10	15	20	25	30	40
50	5	8	10	14	16	20
60	6	9	12	15	18	24
80	8	12	16	20	24	32
100	10	15	20	25	30	40
150	15	24	30	40	45	60
200	20	30	40	50	60	80

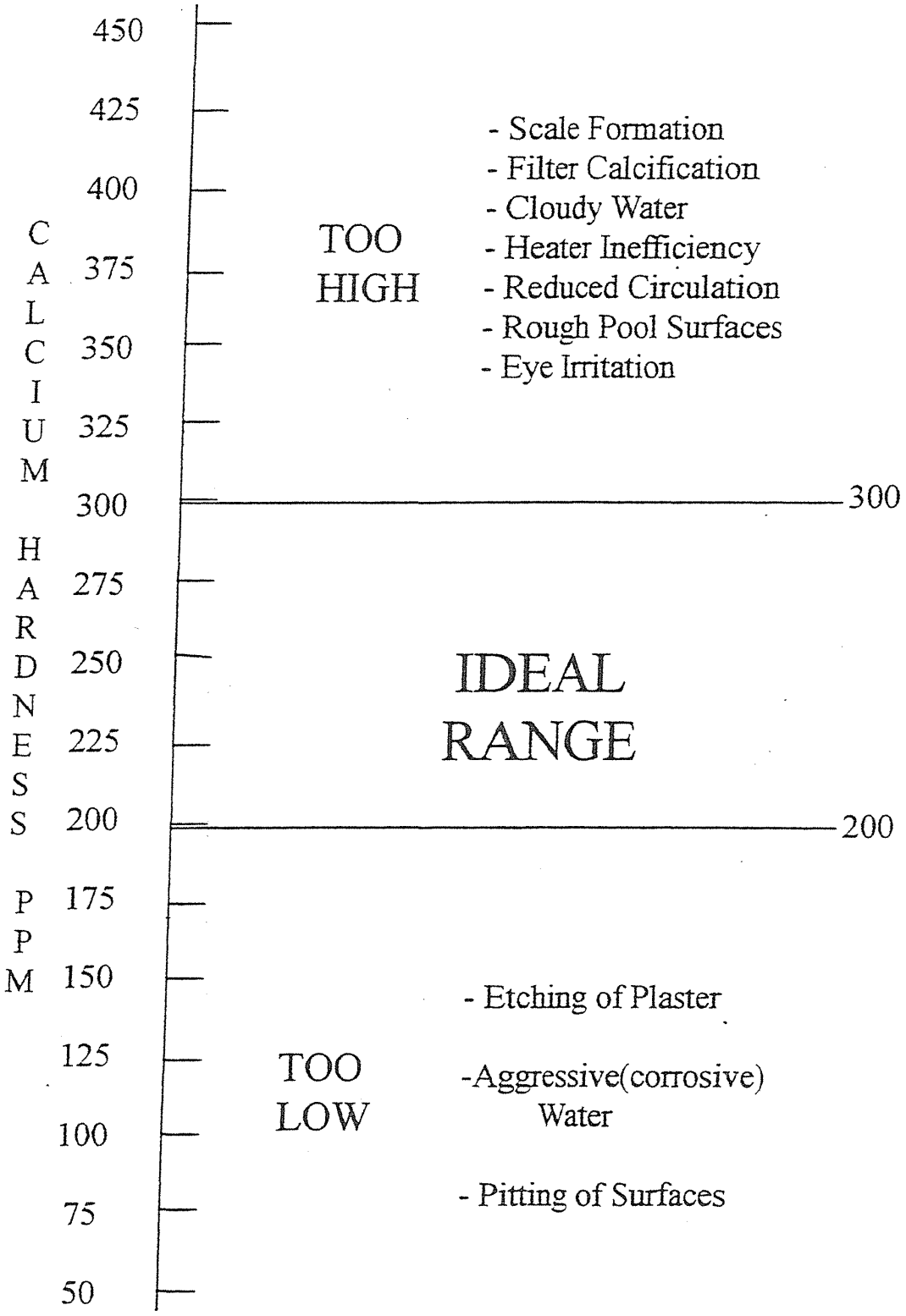
pH and Its' Effects



pH CHART AND THINGS WHICH AFFECT IT



CALCIUM HARDNESS



Typical Recirculation System

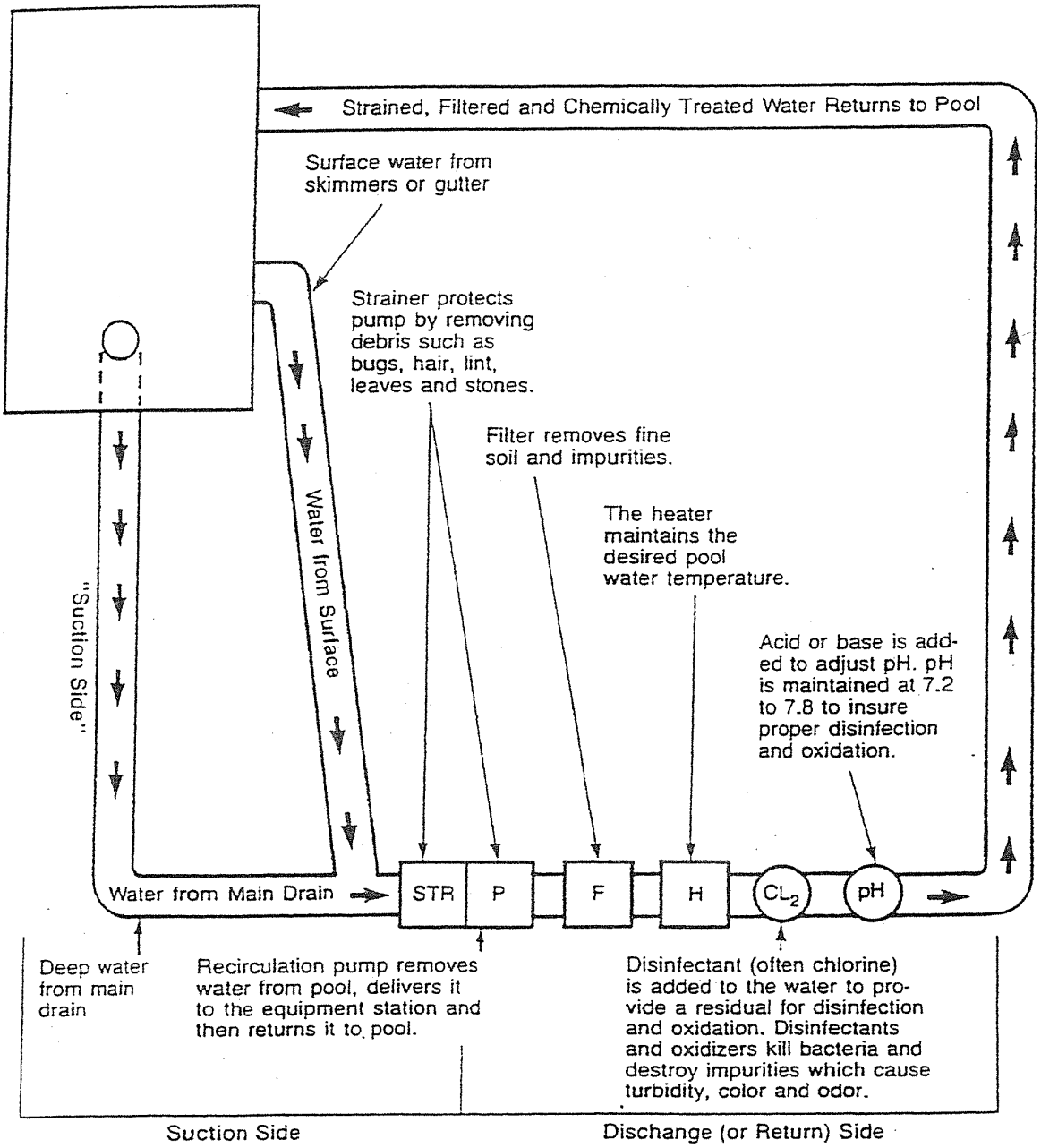
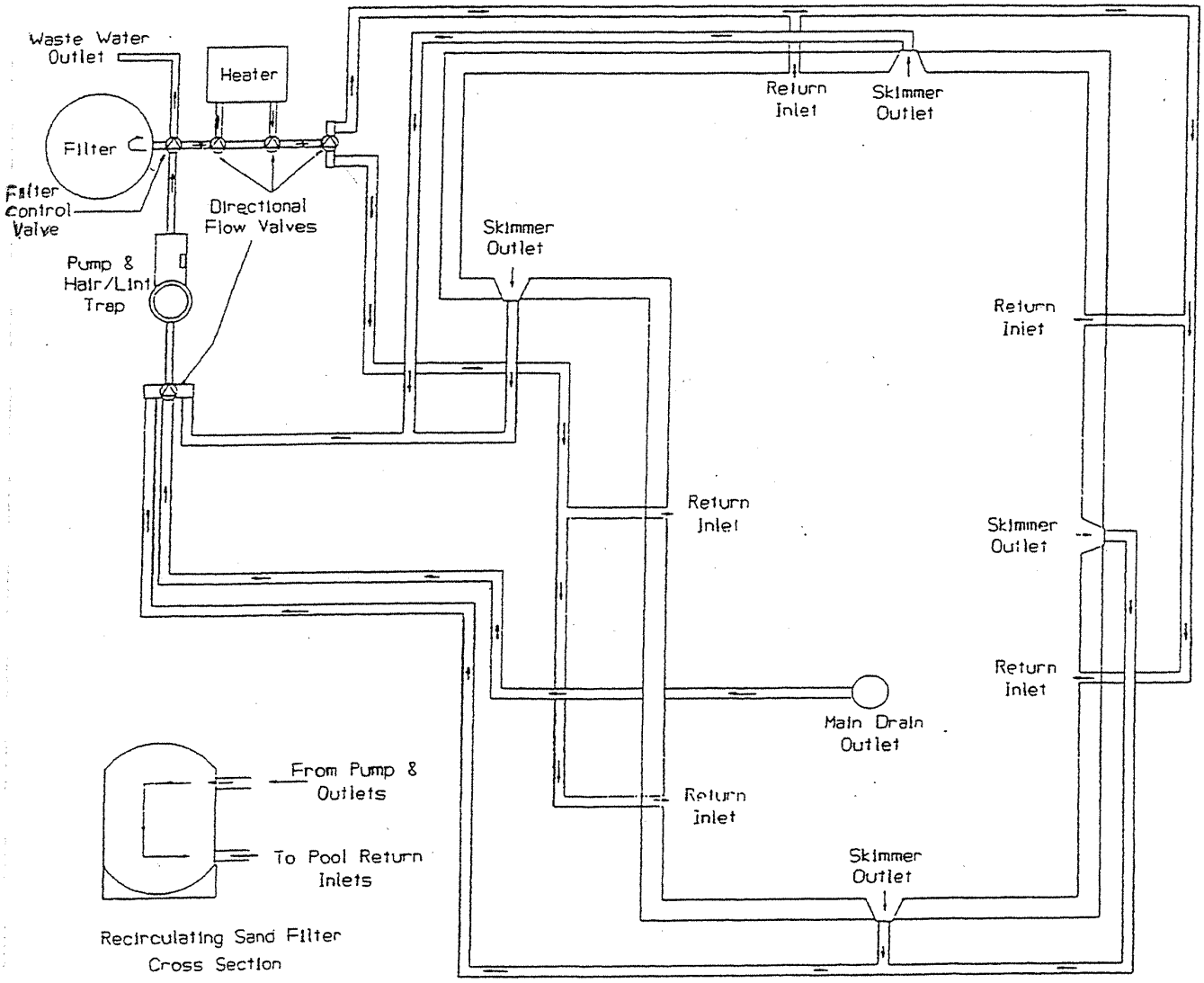
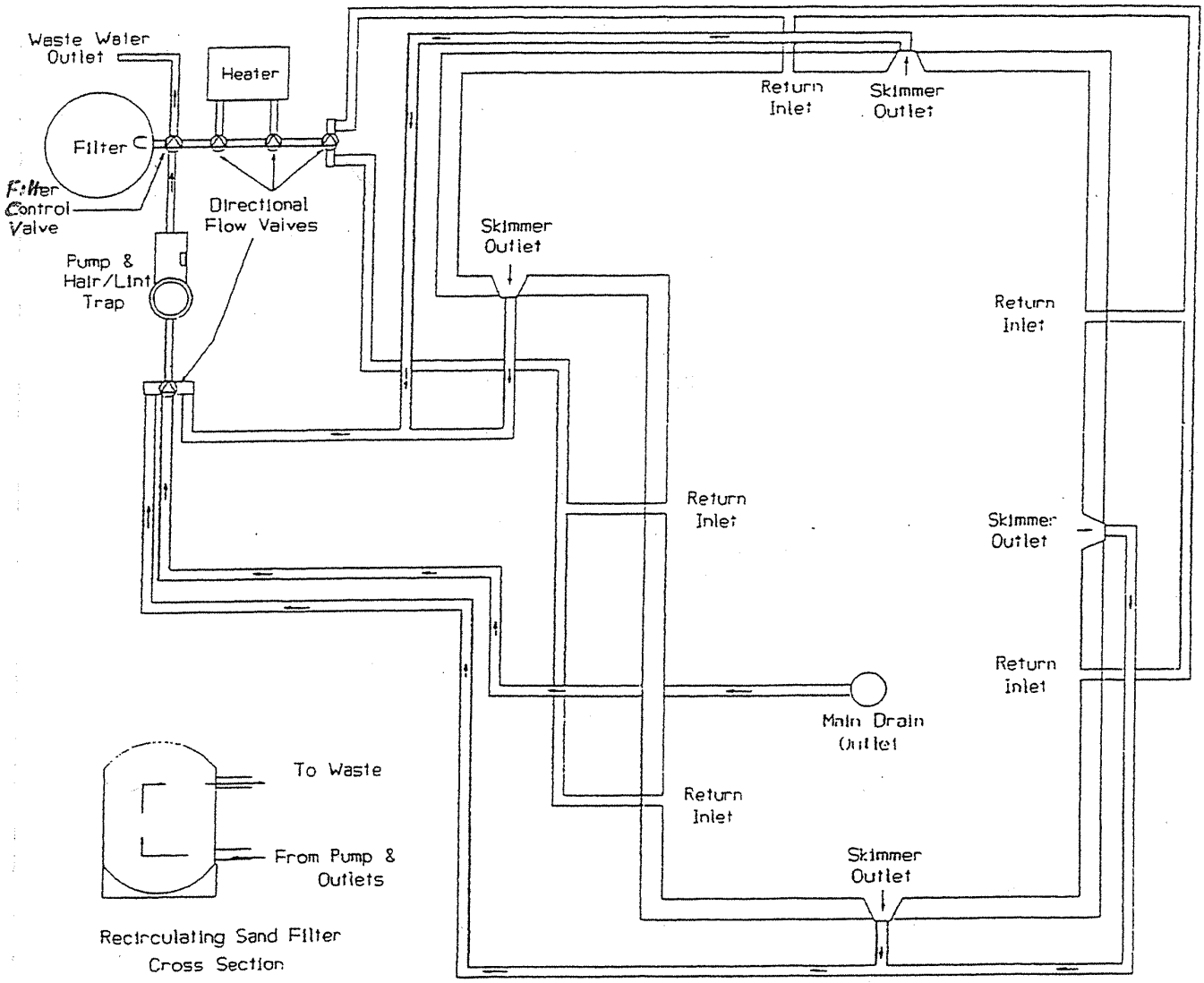


FIGURE 2(A)



Typical Pool Recirculation System & Filtration Process

FIGURE 2(B)



Typical Pool Recirculation System & Backwash Process

FIGURE 2(C)

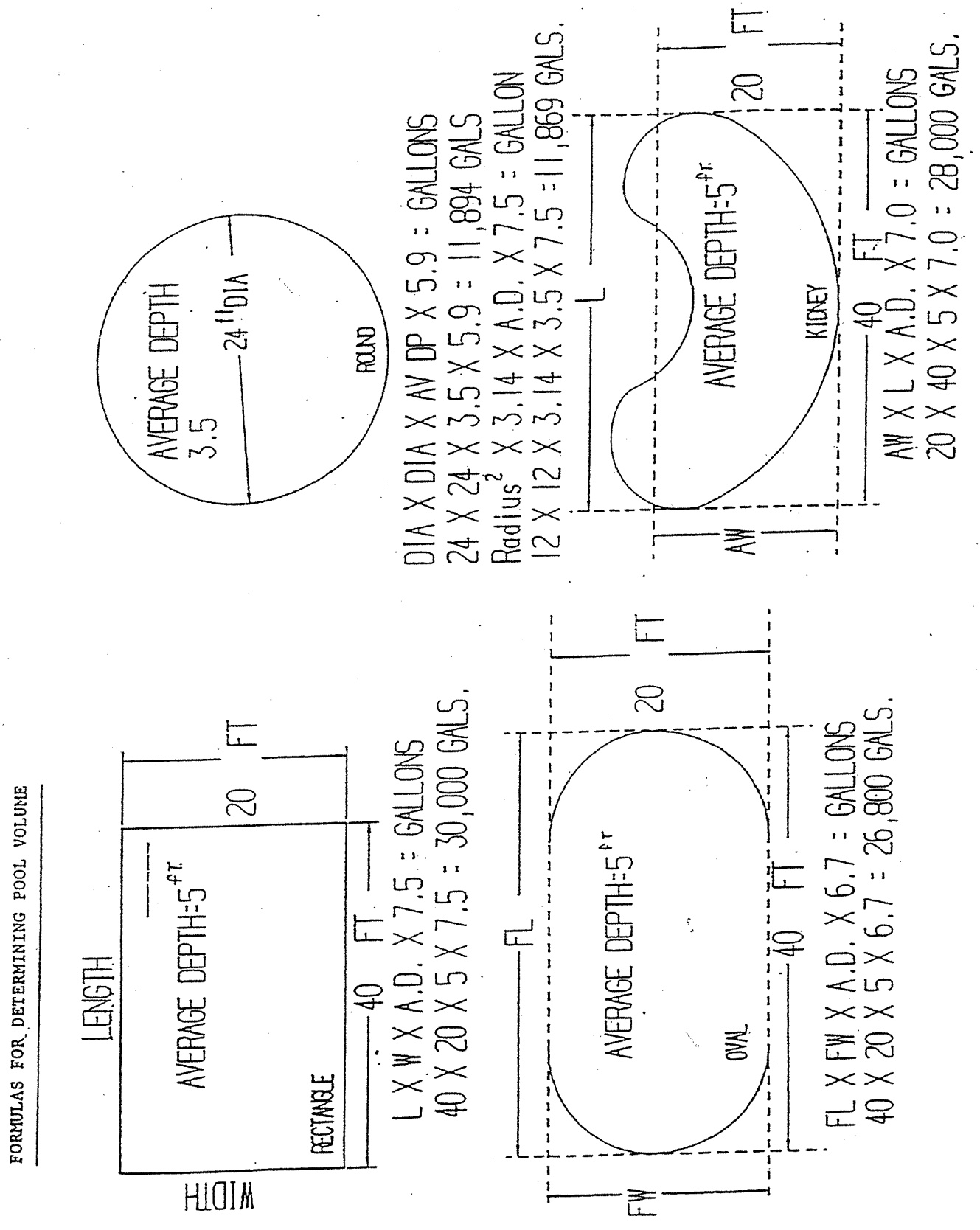
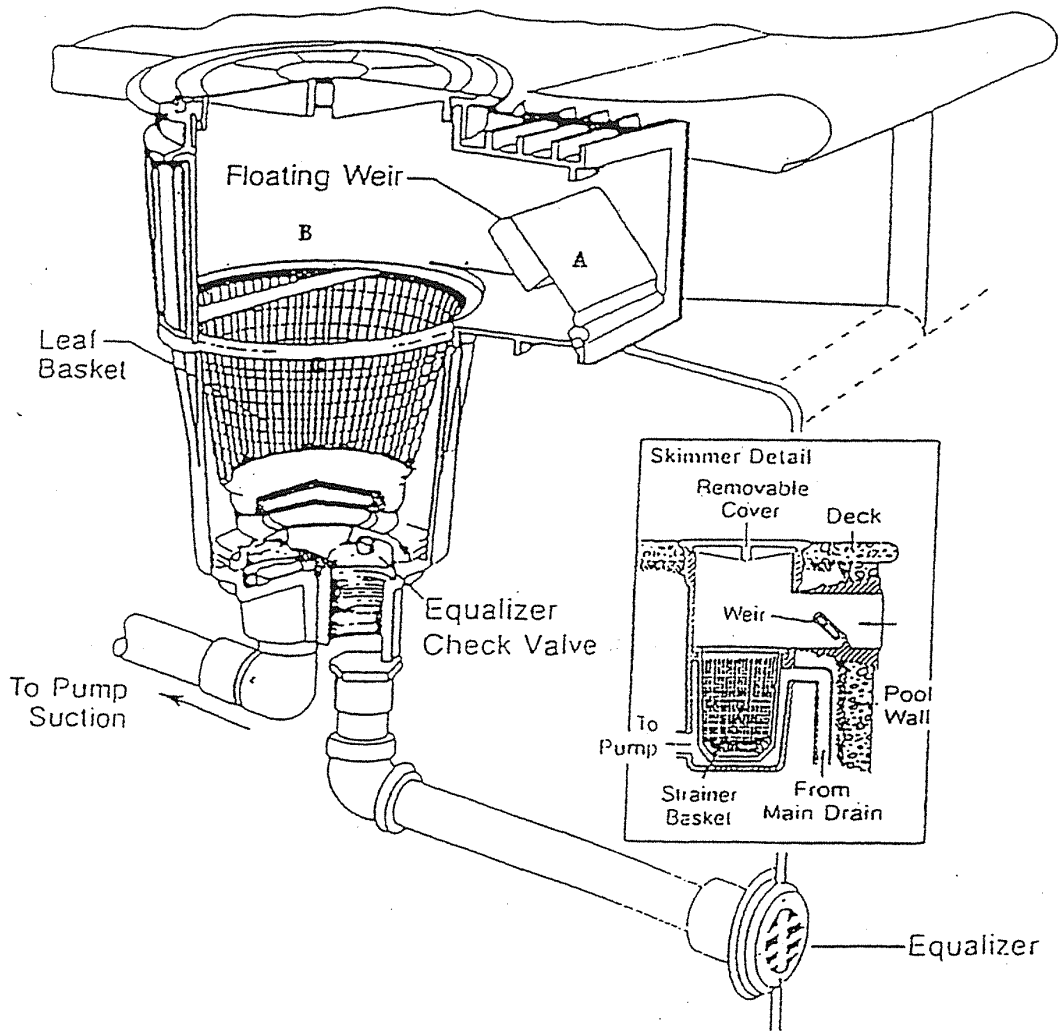

FORMULAS FOR DETERMINING POOL VOLUME
LENGTH
WIDTH
AVERAGE DEPTH=5 ft.
20 FT
40 FT
RECTANGLE
L X W X A.D. X 7.5 = GALLONS
40 X 20 X 5 X 7.5 = 30,000 GALS.
FL
FW
AVERAGE DEPTH=5 ft.
20 FT
40 FT
OVAL
FL X FW X A.D. X 6.7 = GALLONS
40 X 20 X 5 X 6.7 = 26,800 GALS.
AVERAGE DEPTH
3.5
24 "DIA
ROUND
DIA X DIA X AV DP X 5.9 = GALLONS
24 X 24 X 3.5 X 5.9 = 11,894 GALS
Radius² X 3.14 X A.D. X 7.5 = GALLON
12 X 12 X 3.14 X 3.5 X 7.5 = 11,869 GALS.
L
AW
AVERAGE DEPTH=5 ft.
20 FT
KIDNEY
40 FT
AW X L X A.D. X 7.0 = GALLONS
20 X 40 X 5 X 7.0 = 28,000 GALS.

FIGURE 2(D)



Typical Skimmer Cross-Section

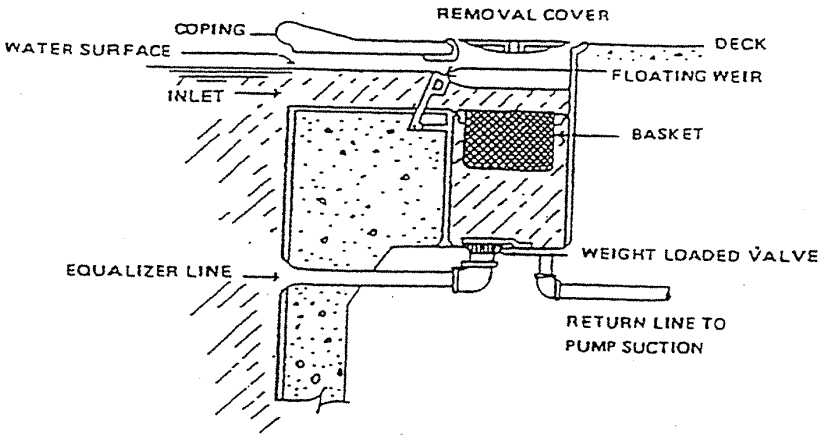


FIGURE 2(G)

Typical overflow rim systems

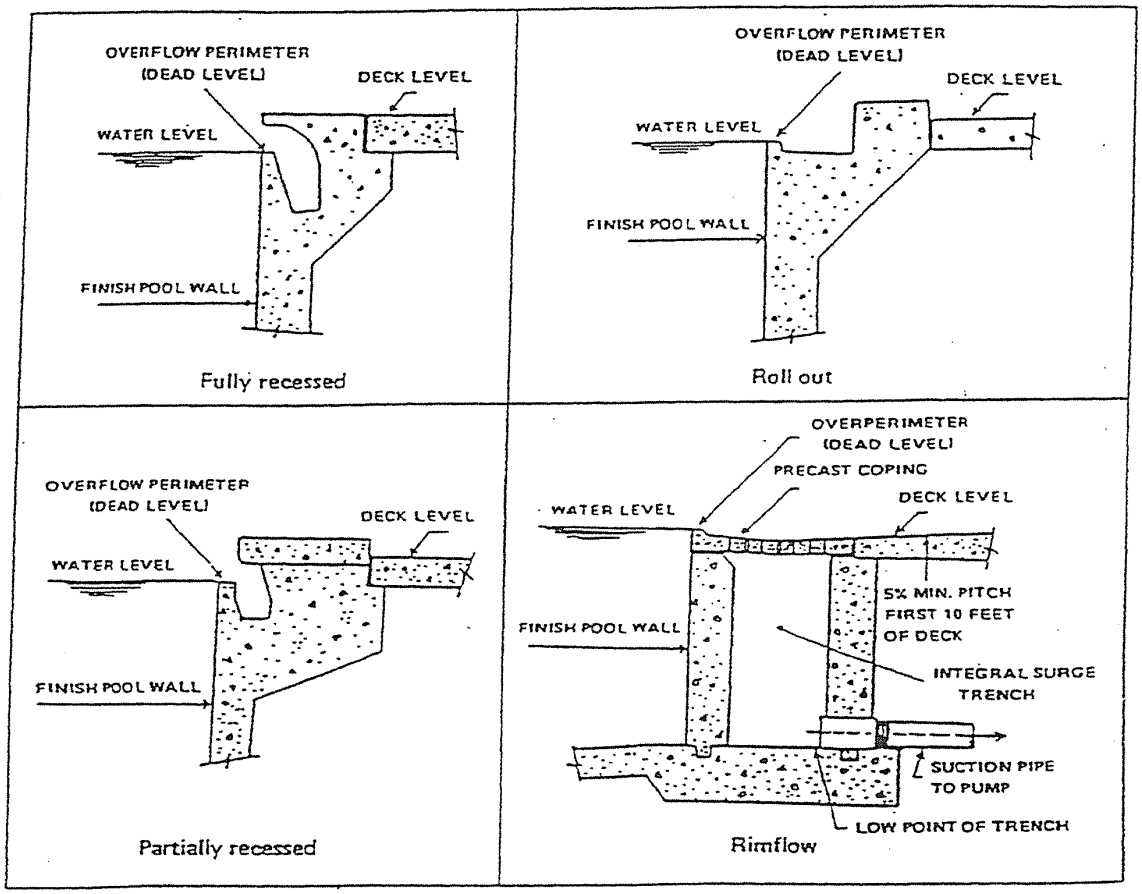


FIGURE 2(H)

FILTRATION SYSTEMS

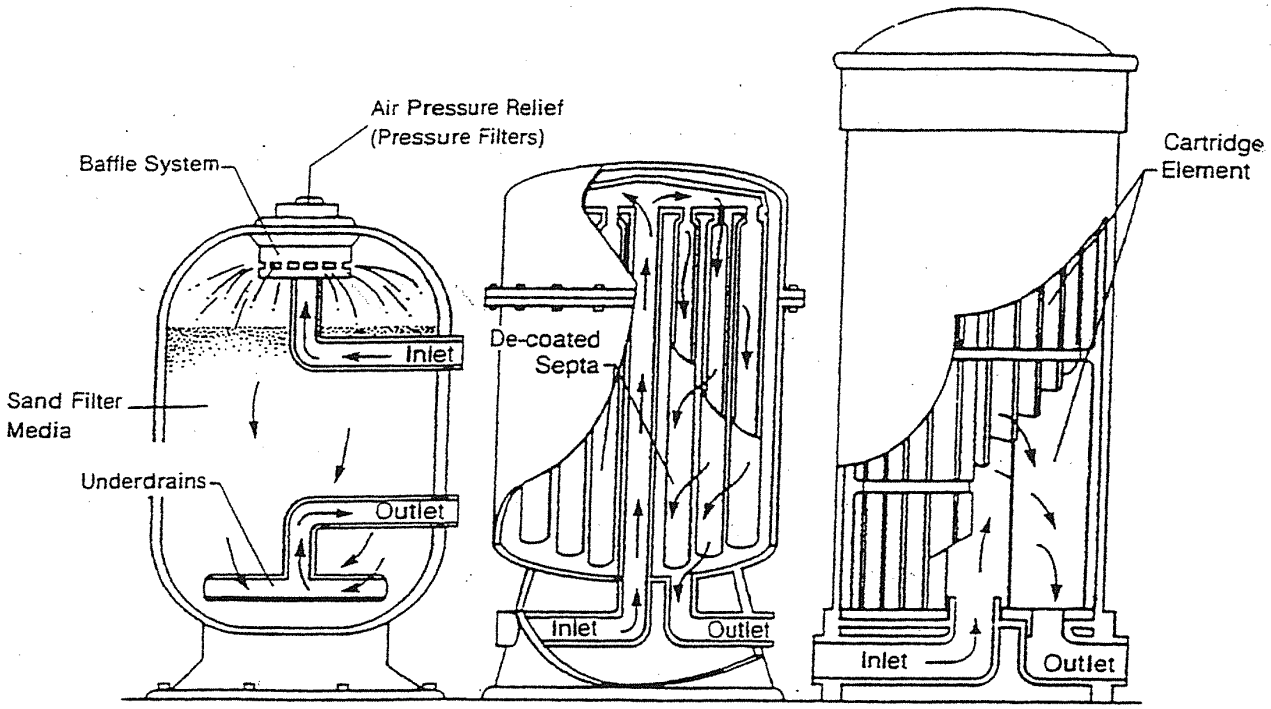
Pool Area (sq. ft.)	Capacity (gal. X 1000)	High Rate Sand Filters			Pressure DE Filters			Cartridge Filters		
		Filter Area (sq. ft.)	Gallons Per Minute	Pump Horsepower	Filter Area	Gallons Per Minute	Pump Horsepower	Filter Area	Gallons Per Minute	Pump Horsepower
<375	<15	1.4	25-30	1/2	15	25-30	1/2	45	30	1/3 - 1/2
375-600	15-25	2.2	30-45	3/4	20-25	35-50	1/2 - 3/4	70	50	1/2 - 3/4
600-850	25-35	3.1	45-60	3/4 - 1	30-35	55-70	3/4 - 1	100	75	3/4 - 1
850	35-45	4.9	75-95	1 - 1 1/2	35-40	70-80	1 - 1 1/2	135	95	1 - 1 1/2

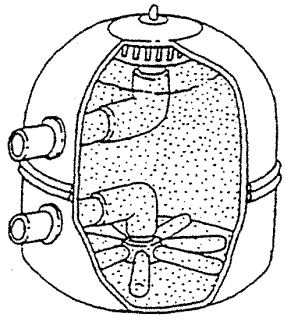
(Average depth of 5 1/2 feet, turnover rate of 8 hours; may vary from manufacturer to manufacturer)

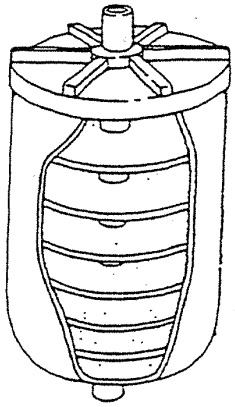
FILTER CHARACTERISTICS

Type of Filter	Filter Rates (gpm/sq.ft.)	Backwash Rates	Filter Additive	Notes
Slow Rate/Gravity (vacuum)	1/2 - 1	8-10	alum (2oz./sq.ft.)	Backwash one tank (or pit) at a time to achieve backwash rate.
Rapid Rate Sand	2-5	12-15	alum (2oz./sq.ft.)	Same as slow rate / gravity filter.
High Rate Sand	15-25	15-25	none	20 gpm is recommended by most manufacturers.
Pressure DE	1-2	1-2	DE (1.5 - 2.5 oz./sq.ft.) or continuous feed	Backwash multiple tanks separately.
Vacuum DE	2-3	External Washing	Same as Pressure DE	Above level tank requires 2 pumps.
Cartridge, Surface	.375 - 1	External Washing	Small Amounts of DE	
Cartridge, Depth	3-8	External Washing	Small Amounts of DE	

FIGURE 2(J)


Air Pressure Relief
(Pressure Filters)
Baffle System
Inlet
Sand Filter
Media
Underdrains
Outlet
De-coated
Septa
Inlet
Outlet
Cartridge
Element
Inlet
Outlet
Backwash to Clean
High-Rate Sand Filter
Backwash and Open to Clean;
Recoat Grids with Media
DE Filter
Hose Off Elements
to Clean
Cartridge Filter


SAND


DE

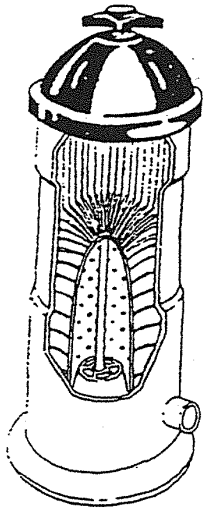
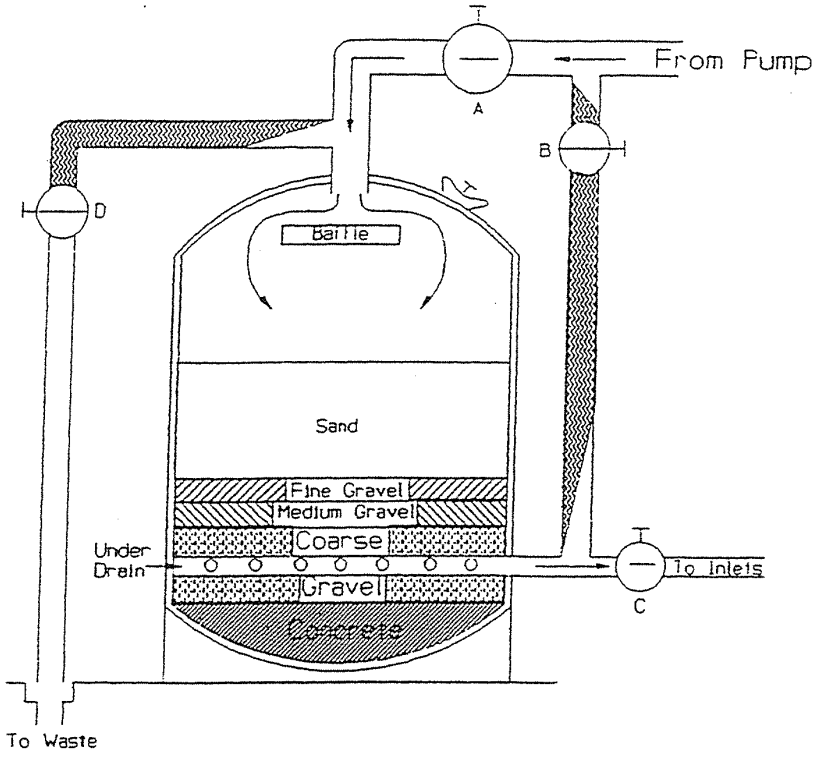
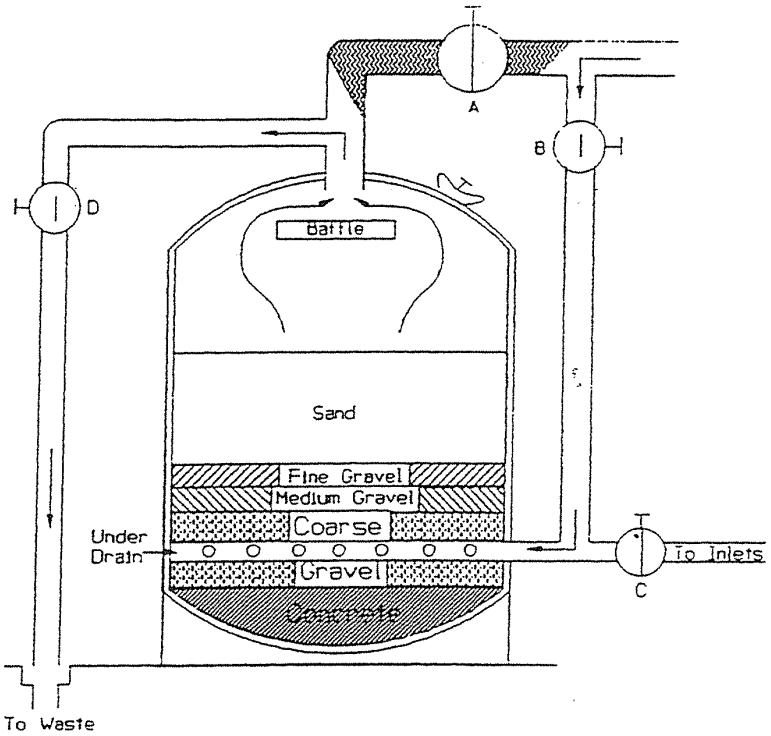

CARTRIDGE

FIGURE 2(K)

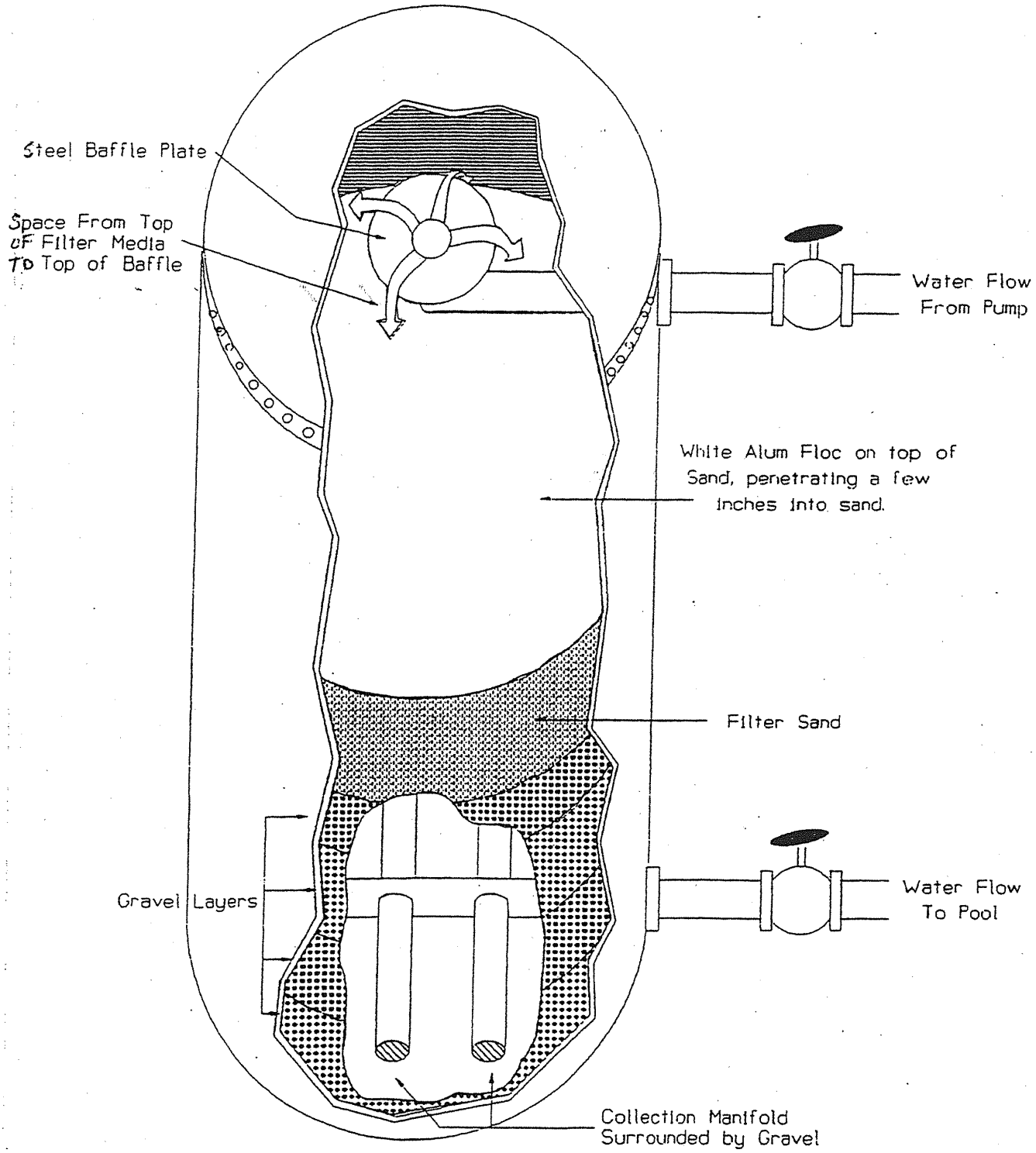


Internal Assembly Pressure Sand Filter
Filtration Cycle - Close Valves B & D, Open Valves A & C



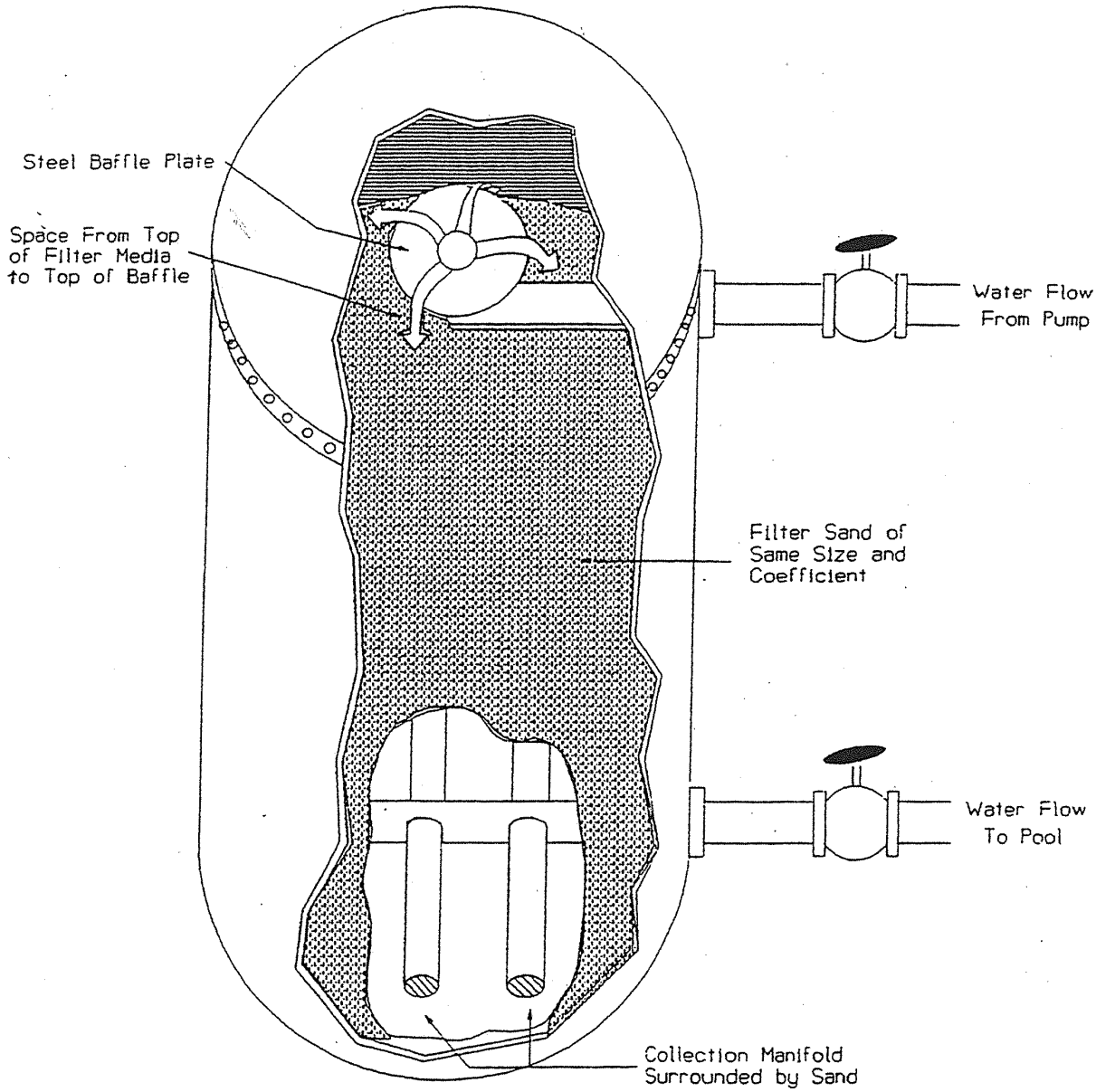
Internal Assembly Pressure Sand Filter
Backwash Cycle - Open Valves B & D, Close Valves A & C

FIGURE 2(L)



Cross Section of a Rapid Sand Filter

FIGURE 2(M)



Cross Section of a High Rate Sand Filter

FIGURE 2(N)