Public Swimming Pool Operators' Course

Florida HEALTH
Collier County

Please note: During the test, you may use this book for reference. You may not use cell phones, tablets, or other people for help. **Anyone not taking the test will NOT be allowed in the room. A DOH employee will be available for assistance if you do not understand a question.

**All exams are in English for grading purposes, though this book is available in English and Spanish.

2016 Version

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Glossary of Common Terms

Term	Definition
Algae	Microscopic vegetation
Backwash	Cleaning the filter by forcing water backwards through the filter. Dirty water is sent to waste.
CAC	Combined Active Chlorine
Calcium Chloride	Used to increase calcium hardness; $CaCl_2$
Calcium Hypochlorite	Solid form of chlorine without stabilizer present; $Ca(OCl)_2$
Chlorine	Cl_2
Cross Connection Device	Device that prevents pool water from being suctioned into the public water supply.
Cyanuric Acid	Chemical that acts as a chlorine stabilizer
Free Active Chlorine	FAC
Hydrochloric Acid	HCl
Hypochlorous Acid	HOCl
Muriatic Acid	Lowers pH and total alkalinity (about 30% HCl)
pH	Value expressing hydrogen ion activity measured on a scale from 0-14. 7 is considered neutral pH; below 7 is considered acidic and above 7 is considered basic.
Sodium Bicarbonate	Baking soda: used to raise total alkalinity; $NaHCO_3$
Sodium Bisulfate	Dry acid: lowers pH and total alkalinity; $NaHSO_4$
Sodium Carbonate	Soda ash; raises pH rapidly; Na_2CO_3
Sodium Hypochlorite	Liquid chlorine; NaOCl
Total Alkalinity	Measurement of the water's ability to resist change; TA
Total Available Chlorine	TAC
Trichloro/Isocyanuric Acid	A stabilized chlorine product (i.e., Trichlor tablets)

Chapter 1. Florida Laws and Regulations

Florida Statutes, Chapter 514

What is a public pool?

Florida Statutes, Chapter 514 defines a "public pool" as a conventional pool, spa-type pool, wading pool, special purpose pool, or water recreation attraction, that includes (but is not limited to) pools operated by or serving: camps, churches, cities, counties, day care centers, group home facilities for eight or more clients, health spas, institutions, parks, state agencies, schools, subdivisions or cooperative-living type projects of five or more living units, including apartments, boarding houses, hotels, mobile home parks, condominiums, motels, recreational vehicle parks, and townhouses.

Are there exemptions from regulation?

Yes, there are 3 types of exemptions from regulation:

- Private pools and water therapy facilities connected with hospitals, medical offices and licensed physical therapy establishments.
- Pools serving no more than 32 condominium or cooperative units, which are not operated as a public lodging establishment (except for water quality).
- Pools serving more than 32 condominium or cooperative units, whose recorded documents prohibit the rental or sublease of units for periods of less than 60 days. However, these types of pools are inspected annually for water quality and life-saving equipment.

Exemptions must be renewed every 5 years through the county health department.

Florida Administrative Code, Chapter 64E-9

Chapter 64E-9 of the Florida Administrative Code regulates the operation and maintenance of public swimming pools. Regardless of where you are in Florida, the same rules apply for all public swimming pools.

Pool Area

Water Clarity/Algae Control: Pool must be kept clean by brushing and/or vacuuming and the water shall be clear, so that at all times, the main drain(s) is/are clearly visible from the pool deck.

Deck/Walkways: Decks and walkways should be intact, non-porous and free of algae, dirt and debris that could potentially enter the water. The wet deck area (4 feet around the edge of the pool) should be free of obstructions, including deck chairs and tables.

Tile/Pool Finish: The pool finish must be free of cracks and staining. Tiles should be free of chips or cracks. Tiles on step edges and gutters for the width of steps should be slip-resistant.

Main Drains: Main drain grates must be Virginia Graeme-Baker (VGB approved) and replaced per manufacturer's instructions. Grates must be intact, with no broken ridges and secured in place with 4 screws.

Lighting: In order to be approved for "night swimming," the pool must have sufficient lighting around the pool deck (3 foot candles of light on the pool wet deck) and in the pool itself (1/2 watt per square foot surface area). For these pools, lights must be in good working order. For all pools, lights must be secured into the niche, the light rim must be free of algae and intact and the light itself must be free of water or debris.

Pool Cover: If a pool is going to be kept covered with a pool cover, the entire pool area must be inaccessible to users. The gates to the pool must be kept locked while the pool cover is in place. When the pool is open to swimmers, the pool cover must be stored at least 4 feet away from the edge of the pool.

Pool Safety

All pools are required to have safety equipment, consisting of a shepherd's hook securely attached (with 2 metal bolts) to a one-piece pole at least 16 feet in length and at least

one 18-inch in diameter life ring with sufficient rope attached to reach all parts of the pool from the deck. Pools that are greater than 50 feet in length require at least 2 of each type of safety equipment. Spas and wading pools under 200 square feet of surface area are exempt from this requirement.

For pools with slope transition lines, a safety line must be in place at all times, unless a lifeguard is present. The safety line must be mounted 2 feet toward the shallow end of the slope break/tile line.

Rules and regulations for bathers must be posted conspicuously in the pool area and must be visible from the pool and deck. A pool sign must contain the following rules in minimum 1-inch lettering:

- No food or drinks in the pool or on the pool wet deck.
- No glass or animals in the fenced pool area (or within 50 feet of unfenced pool).
- Shower before entering.
- Bathing load: _____ persons (contact Health Department for specific pool).
- Pool hours: _____ a.m. to _____ p.m.
- Do not drink the pool water.

In addition to the above pool rules, spa rules signs must also contain the following:

- Maximum water temperature: 104°F.
- Maximum use time: 15 minutes.
- Children under 12 must have adult supervision.
- Pregnant women, small children, people with health problems and people using alcohol, narcotics or other drugs that cause drowsiness should not use spa pools without first consulting a doctor.
  **When a spa is equipped with an emergency cut-off switch, an additional rule/sign shall read: "Alarm indicates spa pump is off. Do not use spa when alarm sounds until advised otherwise."

A clock must be visible from the spa pool to assist users in meeting the time requirement.

Pools without an approved diving well shall have "NO DIVING" posted in minimum 4-inch letters included with the above listed pool rules.

Water Quality

Each pool must have a test kit onsite, capable of checking free active chlorine (FAC), total available chlorine (TAC) pH, total alkalinity (TA) and calcium hardness (CH). When a stabilized chlorine product is used, such as Trichlor-tablets, it is necessary to also be able to test for cyanuric acid. Maximum cyanuric acid levels for pools are currently 100 ppm for pools and 40 ppm for spas. Supplemental test kits may be required if additional water treatment methods are used.

Either chlorine or bromine is required for pool disinfection. All pools must have a disinfection feeder capable of continuously feeding at least 6.0 mg/L of disinfectant to the recirculation flow. Free active chlorine must be a minimum of 1.0 ppm for swimming pools and a minimum 2.0 ppm for spas, with a maximum of 10.0 ppm. Bromine levels must be a minimum of 1.5 ppm in pools and 3.0 ppm in spas, with a maximum of 10.0 ppm. For indoor swimming pools/spas, the maximum chlorine level is 5.0 ppm and the maximum bromine level is 6.0 ppm.

The pH of the pool water must be maintained at all times within the range of 7.2 – 7.8.

Equipment Room

As previously stated, all pools and spas must have a disinfection feeder capable of continuously feeding a dosage of 6 mg/L to the recirculation flow. Feeders are sized at the time of pool construction and/or modifications, so for day-to-day maintenance, assume the feeders are the correct size.

pH adjustment feeders are required, except for on pools that use an erosion-type chlorine feeder and have been "approved" without the pH feeder. For all new pools, if an erosion chlorine feeder is installed, a pH adjustment feeder is required.

Oxidation-Reduction Potential (ORP) controllers used in connection with chlorine and pH feeders are required on spas, wading pools and interactive water features. Other types of sanitizers may be used for supplemental water treatment. These include ozone, silver, copper ionization, chlorine generators (salt generators), and UV light. All additional water treatment methods must be pre-approved by the Florida Department of Health and local Building Department.

The manual addition of chemicals (hand-feeding) is allowed ONLY under special conditions, such as super-chlorination, and requires the pool to be closed for at least one hour.

After super-chlorination (18-24 hour procedure), or "shocking the pool," the pool can be re-opened when the free chlorine levels drop to 10.0 ppm.

All equipment designed for recirculation, filtration and disinfection shall be properly maintained and operated 24 hours per day. If the equipment is on a timer, the pumps must turn on 3 hours before the pool opens and may shut off 3 hours after the pool closes.

Circulation of the entire pool volume must be accomplished in 6 hours, for a total of 4 turnovers per day. Spa water must be recirculated every 30 minutes and wading pools every hour. A flowmeter is required on the main return line of the pool (after the heater lines) to monitor adequate flow rates. All equipment, including pumps and filters, must be kept clean and in good repair to ensure proper flow. When a pool or spa is heated, a thermometer is required and must be placed on the main return line (after the heater lines). The maximum water temperature is 104°F.

A daily record (log) regarding pool operation and water quality is required to be kept on-site as well as a copy of the pool operator certification. In addition, every pool should have a DOH-approved test kit on site, capable of testing for free and total chlorine (using DPD) or bromine level, total alkalinity, calcium hardness and pH. Pools that use stabilized chlorine must also have test kits for cyanuric acid.

When is a pool unsafe to use?

A manager, pool operator or inspector can and should close the pool for the following reasons:

- Free active chlorine residual below the minimum required or above the maximum allowable 10.0 ppm.
- Main drain grate(s) is/are not visible due to cloudy water.
- Severe algae growth causing slippery surfaces and/or harboring bacteria.
- Known contamination, such as vomit or feces, or when a pool has tested positive for bacteria.
- Broken glass or foreign objects.
- Dogs or other animals in the pool.
- Excessive use of chemicals.
- Scum in overflow gutters or on pool walls.
- Showers or bathrooms inoperable.
- Failure of equipment operation (i.e., pump is off, filters missing).
- Pool finish is cracked/peeling/eroding.
- Any situation or condition that is unsafe and may result in injury or health hazard.

How do I determine bather loads for the rules sign?

- Pools: One person per 5 gpm of flow rate (Example: 100 gpm flow = 20 persons)
- Spas: One person per 10 square feet of surface area
- **Contact Florida Department of Health in Collier County for records.**

Florida Building Code, Chapter 454

In 2012, the Florida legislature determined the Building Departments would be responsible for approving plans and work for the construction of new swimming pools and the modification of existing pools.

Florida Building Code, Chapter 454, details the specific engineering and design criteria for the construction and modification of public swimming pools. A Florida-licensed professional engineer is required to design the pool and submit the plans to the local building department, as well as to the Health Department, for review and approval.

If a pool is modified or altered in such a way that it is no longer in accordance with the original plans and specifications, then prior approval is needed from both the local building authority and the Department of Health. Modifications include non-equivalent changes or additions to the recirculation system, treatment equipment, physical structure or appurtenances. Replacement of equipment with an equivalent piece of equipment is not considered a modification. Resurfacing the pool interior is not considered a modification; however, there are several items that must be addressed at time of resurfacing. Therefore, for resurfacing, you must contact the local building authority AND the Florida Department of Health.

Florida Building Code Violations are listed as follows:

	Type A (Immediate Closure)	**Type E (Correct by June 30th)**
Depth Markers	3 or more missing or illegible	1 or 2 missing or illegible
Handrail/Ladder	Missing or Inoperable	Loose; missing escutcheon plates
Step Markings	Over 50% of tread length of step edge missing or faded.	Over 10% tread length of step edge missing or faded.
Gutter Grates/Skimmer	Jagged edge on broken grate, missing skimmer cover on deck.	3 or more grates missing or broken; skimmer weir door broken or missing.

"No Dive Markings"	3 or more markers in <5 feet of water missing or illegible.	Any markers missing or illegible.
Diving Board	Rail over the deck on 1 meter or higher missing; board broken/not secured to deck.	Loose
Deck Shower		Missing or inoperable
Chemical Container Label	Mislabeled or not labeled	Almost illegible
Vacuum Cleaner	Plug or cover missing or broken	Vacuum inoperable
Gas Chlorine	Leaking gas	Scale inoperable; certification out of date.
Waste Water		No air gap before sewer.
DE Separator		Missing or inoperable.
Equipment Change	When it causes another Type A violation	Reduces allowable bathing load by flow loss >20%.
Fences/Gates	Breach including 4 foot height no longer compliant, unstable/unsecured or gate latch not operable.	

Any Florida Building Code violations notated by the DOH inspector are forwarded to the local building department for review.

Collier County Ordinances

Sec. 66-117. Pool Operator's Certificate

(a) From the effective date of this article, it shall be unlawful for any person, corporation, partnership, association, or other legal entity to operate and/or maintain a public swimming pool unless and until some person directly responsible for the maintenance and care of such swimming pool shall first obtain a pool operator's certificate from the health department, which must be displayed in the pool area. The pool shall have daily maintenance and records of the daily maintenance must be retained on the pool site for review by the health department.

(b) All persons engaged in public swimming pool services or maintenance must acquire a pool operator's certificate from the health department. Pool service contractors holding a current license to operate issued by the county or by the State of Florida are excluded from this requirement. All pool service contractors must be prepared, upon oral request by the Health Department, to immediately present this license at the pool for inspection.

(c) The pool operator's certificate will be valid for three (3) years and may be reissued upon payment of an additional fee of twenty dollars ($20.00). Certificates valid on the effective date of this ordinance will remain valid until September 30, 2001.

(d) A pool operator's certificate issued pursuant to section 66-118(b) shall be valid for the time periods specified in subsection (c) above, unless sooner revoked for cause by the health department. Continued violation of any provision of the Florida Administrative Code, Chapter 64E-9, as amended, shall be prima facie grounds for revocation of the pool operator's certificate. The certificate may be declared invalid if the holder does not attend a refresher course as prescribed by the Health Department. Such refresher courses shall not be required more frequently than annually.

(e) In lieu of a pool operator's certificate, a provisional certificate will be issued for an individual on registration of the course. This provisional certificate will be valid until the date of satisfactory completion of the course, or for six (6) months, whichever occurs first.

(f) A fee of fifty dollars ($50.00) shall be charged by the Health Department for all of the following: processing applications, issuing a certificate, conducting the course and supplying the required educational materials.

Section 66-119. Swimming Pool Water Quality

(a) The health department will conduct unannounced inspections of public swimming pools (including water sampling) at least two times per year, but not more frequently than four times per year for each pool. Each water sample shall be analyzed for bacterial contamination. Upon a positive reading of the sample, the pool owner or owner's representative will be notified of the positive reading. The swimming pool and adjacent areas shall be immediately posted as being "closed" and shall remain closed until completion of the required super-chlorination procedures.

(b) In the event of fecal contamination of any pool water, the health department must be notified immediately by the staff of the swimming pool; the pool and adjacent area shall immediately be posted as "closed." All solids must be removed, filters must be backwashed and be thoroughly cleaned, and the pool shall be super-chlorinated to 20 parts per million (ppm). The chlorine level shall be checked to assure that it meets the applicable standards before the pool is reopened.

Chapter 2. Maintaining Water Chemistry

Maintaining water balance, or "chemical equilibrium," is a necessity to properly maintaining a public swimming pool. Water that is correctly balanced contributes to the health and well-being of anyone using the pool. In addition, correctly balanced water prevents damage to the equipment and the pool itself, as well as increases the effectiveness of the sanitizing agent.

Water naturally dissolves chemicals, metals and elements that it comes into contact with until the water becomes saturated. Water attempts to achieve a balanced equilibrium: If that water becomes too saturated, excess material will precipitate out of the water. To determine if the water is balanced, pool operators should calculate the "Saturation Index."

The Saturation Index consists of 5 factors, including: pH, water temperature, calcium hardness, total alkalinity, and total dissolved solids. These factors make up what is known as the Langelier Saturation Index:

SI	=	pH	+	Tf	+	Cf	+	Af	-	TDSf
Saturation Index		pH as tested		Temperature factor		Calcium factor		Alkalinity factor		Total Dissolved Solids factor

Saturation Index Factors

Temperature		**Calcium Hardness**		**Total Carbonate Alkalinity**		**Total Dissolved Solids**	
°F	Tf	ppm	Cf	ppm	Af	ppm	TDSf
32	0.0	25	1.0	25	1.4	<1000	12.1
37	0.1	50	1.3	50	1.7	1000 +	12.2
46	0.2	75	1.5	75	1.9		
53	0.3	100	1.6	100	2.0		
60	0.4	125	1.7	125	2.1		
66	0.5	150	1.8	150	2.2		
76	0.6	200	1.9	200	2.3		
84	0.7	250	2.0	250	2.4		
94	0.8	300	2.1	300	2.5		
105	0.9	400	2.2	400	2.6		
		800	2.5	800	2.9		

*For values in between, use the next highest number. Example: For pool temperature of 102°F, use the Temperature Factor for 105°F (0.9)

Example 1: Determine the saturation index if your pool water readings are:

pH	7.2
Temperature	84°F
Calcium Hardness	200 ppm
Total Alkalinity	100 ppm
TDS	2200 ppm

SI	=	pH	+	Tf	+	Cf	+	Af	-	TDSf
SI	=	7.2	+	0.7	+	1.9	+	2.0	-	12.2
				SI	=	- 0.4				

Example 2: Determine the saturation index if your pool readings are:

pH	7.7
Temperature	104°F
Calcium Hardness	400 ppm
Total Alkalinity	120 ppm
TDS	3000 ppm

SI	=	pH	+	Tf	+	Cf	+	Af	-	TDSf
SI	=	7.7	+	0.9	+	2.2	+	2.1	-	12.2
				SI	=	+ 0.7				

What does the Saturation Index Number Mean?

After you've calculated your Saturation Index, the resulting value determines whether the water is balanced:

- Values between – 0.5 and + 0.5 indicate the water is balanced.
- Values above + 0.5 may result in scaling.
- Values below – 0.5 may result in etching.

Scaling is the build-up of calcium deposits on piping, equipment and/or the pool walls, floor, and tiles.

Etching is the corrosion of calcium from pool surfaces. This may produce pitting or wearing of the pool finish.

Adjusting Water Balance

When maintaining or correcting water balance, the operator should always, test, analyze and then treat. The three most important factors in water balance are: total alkalinity (TA), pH and calcium hardness (CH). TA is the most important factor and should be the first factor in balancing pool water.

Total Alkalinity (TA)

Total Alkalinity is a measure of the water's ability to resist change in pH. It consists of carbonate ions or particles in the water. Pool operators must control this "Carbonate Alkalinity" to allow enough calcium carbonate to saturate the water without excess, which will produce scaling. Properly controlled TA prevents fluctuations in pH, or what is known as "pH bounce." Generally, if TA is too low, water becomes aggressive and causes pitting or etching and pH bounce. If TA is too high, water tends to form scale and cloudiness, and also causes pH bounce.

Because it stabilizes pH, total alkalinity should always be adjusted first. Often when adjusting TA, pH is also adjusted. To increase TA, sodium bicarbonate (baking soda) should be used. This increases TA without greatly affecting pH. A general rule of thumb is to add 1 ½ pounds of sodium bicarbonate for each 10,000 gallons of water to raise TA 10 ppm.

To decrease TA, add muriatic acid or sodium bisulphate (dry acid). Approximately 2 pounds of dry acid added to a 24,000 gallon pool reduces TA 5 ppm. One pint of muriatic acid equals 1.25 pounds of dry acid.

The most effective TA range is 80 – 120 ppm. Keeping TA in this range may avoid many problems. Remember, when adding acid to a pool, dilute the acid in water first. Always add chemicals to water, not water to chemicals. When adding acid, it should be poured in a columnar method, rather than "walking it around the pool perimeter."

pH

The second factor in water balance is pH. pH is an indication or measure of acid activity in the water. Relative acidity is not how much acid is in the water, but the amount of hydrogen ions in the water. When there are more hydrogen ions or particles in the water, the water is said to be more acidic; when there are less, the water is basic.

pH is measured on a scale of 0 – 14, with 7.0 being neutral. Below 7.0, the water is acidic; above 7.0, the water is basic, or alkaline. The pH of the human eye is about 7.5. Chapter 64E-9, FAC requires pH be maintained between 7.2 and 7.8. When the pH is too low, eye irritation and chlorine loss can occur. When pH is too high, chlorine becomes ineffective and eye irritation can also occur. Chlorine effectiveness can change drastically in different pH ranges.

Once TA is in the correct range, pH can then be adjusted. To increase pH, add sodium carbonate (soda ash). One pound of soda ash will increase pH by 0.3 in 10,000 gallons of water. To decrease pH, add muriatic or dry acid. It is wise to consult labels on chemical containers. They provide tables with information on how much chemical too add to cause change.

Calcium Hardness (CH)

The third factor in balanced pool water is calcium hardness. Pool water that has too much calcium tends to deposit it (scale) on the equipment and pool wall, floor and tile surfaces. Pool water with too little calcium becomes aggressive and seeks it from the pool surfaces, causing etching, or wearing of finish.

It is important to know the make-up or source water being added to the pool to determine balancing needs for CH. In general, Collier County public water supplies do not have enough calcium for correct swimming pool water balance. It is usually necessary to add calcium chloride to increase CH concentrations. Normally, CH should be in the range 200 – 400 ppm, depending on other water balance factors. Using 10 pounds of calcium chloride will raise CH 80 ppm in 10,000 gallons of water.

Temperature and Total Dissolved Solids (TDS)

Normal pool temperatures in Collier County vary between 80 and 90°F, so temperature is not a significant factor in the saturation index. However, higher water temperatures will affect saturation. Calcium is less soluble in warm water, so cloudiness will occur at lower calcium levels in warmer waters, such as spas, than cooler water.

Total dissolved solids do not affect water balance when the concentration is less than 2000 ppm. TDS should be checked if water clarity is compromised to determine the level. Generally, TDS levels are kept lower through constant evaporation and refilling. When TDS and CH are too high, the only method of lowering them is by partially draining the water and refilling with fresh source water.

Calculating Pool Volume

To adjust TA, pH and CH, you'll need to know how many gallons are in the swimming pool. Pool volume can be calculated as follows:

Pool Volume = Length x Width x Average Depth x 7.5

You can also find gallons printed on the pool's operating permit or contact the Department of Health to obtain pool sizing specifications.

Changing the Pool Water

For regular-sized swimming pools, the Health Department does not recommend completely emptying the pool, as this may affect the integrity of the pool structure itself. In addition, some jurisdictions do not permit large amounts of pool water to be dumped into the sewer, storm water or retention pond systems. Adjusting chemicals as described above is a cheaper and quicker solution to adjusting water balance.

Spas, however, may present more issues with heavy use and chemical build-up in a small body of water. Therefore, in these cases, it is much easier to drain, refill and balance the spa water. The general rule of thumb for changing spa water is:

$$\text{Number of days to change} = \frac{\text{1/3 spa volume}}{\text{Max Number of Daily bathers}}$$

In summation, swimming pool water balance is critical to maintaining a safe and healthy bathing environment, maximizing disinfection efficiency, and protecting pool surfaces and equipment. Total alkalinity, pH and calcium hardness must be kept at correct inter-related levels.

Remember, **test, analyze and then treat**!

Quick Reference Guide

Dosing Requirements per 10,000 Gallons of Water

	Amount of Chemical Needed	Change
Increase TA	1.5 pounds of Sodium Bicarbonate	10 ppm
Increase CH	1.25 pounds of 77% Calcium Chloride	10 ppm
Increase pH	6 ounces of soda ash	0.2
	8 ounces of soda ash	0.4
	12 ounces of soda ash	0.8
Decrease pH	12 ounces muriatic acid	0.2
	16 ounces muriatic acid	0.6

Chapter 3. Disinfection and Sanitation

Disinfectants

Sanitation and disinfection are interchangeable terms that are defined as the "killing off of micro-organisms," such as bacteria, parasites, algae and viruses. The use of a sanitizer accomplishes this and also performs another function, known as oxidation. Oxidation is the "burning off of unwanted matter, such as dirt, dust, oils, and perspiration." Florida Administrative Code, Chapter 64E-9, requires the sanitizers to be used in public pools to be chlorine or bromine.

When chlorine is added to water, it is used up in doing its job of killing off micro-organisms. This creates what is known as chlorine demand. The amount of chlorine leftover is the chlorine residual.

When a chlorine compound is added to water, hypochlorous acid is formed. Hypochlorous acid is the extremely active agent that sanitizes and oxidizes the water. How well it performs these functions is highly dependent on the pH of the water. Hypochlorous acid breaks down into hydrogen ions. As mentioned in Chapter 2, pH is a measure of the hydrogen ions in the water (lower pH = more hydrogen ions). When the pH is high, hypochlorous acid more easily breaks down into hydrogen ions. When the pH is lower, hypochlorous acid breaks down slower, and remains free to act as a sanitizer and oxidizer. The chart below illustrates the effect that pH has on chlorine efficiency:

pH	Hypochlorous Acid (Active) %	Ionized Hypochlorous Acid (Inactive) %
4	100	0
7	75	25
7.5	48	52
8	22	78
11	0.0003	99.9

At a pH of 7.0, 75% of the hypochlorous acid is "Active," or effective as a sanitizer and oxidizer. At a pH of 8.0, only 22% of the hypochlorous acid is "Active." Maintaining proper pH is essential to the ability of chlorine to disinfect the water.

Key Terms in the Disinfection Process

Chlorine Demand – the amount of chlorine necessary to oxidize all the organic matter present in the pool water at any given time.

Chlorine Residual/Free Active Chlorine – the amount of free chlorine remaining in the water after all organic matter has been "burned out;" what is left over after chlorine demand has been satisfied.

Combined Chlorine – Chlorine which is available as a bactericide, but has been rendered relatively ineffective because it is tied up with another substance (usually ammonia). Perspiration and urine from swimmers introduce ammonia into the water. Combined chlorine forms chloramines, which produces odors and causes eye irritation.

Total Available Chlorine – The sum of free active chlorine and combined chlorine.

Breakpoint Chlorination – the process of adding free chlorine to treat, oxidize or remove combined chlorine.

When there is enough combined chlorine present in the water, often times, swimmers will believe there is too much chlorine in the water, causing odors and eye irritation. However, most often, this usually means there is not enough free active chlorine to remove the chloramines. More chlorine must be added to reach breakpoint chlorination. Chlorine added after the breakpoint has been reached will be in the free active state, and usually results in a sharp decrease in total available chlorine.

By using an acceptable test kit, free active and total available chlorine levels can be determined. The difference between the two is the combined chlorine, which contains the chloramines. Chloramines are removed by adding chlorine in the amount of 10 times the combined chlorine level.

Superchlorination – the procedure used to kill algae, and is also required after a sample tests positive for bacteria or in the event of a fecal accident.

The proper superchlorination procedure is as follows:

1. Close the pool to swimmers.
2. Raise the free active chlorine to 20 ppm and maintain pH at 7.2 – 7.5 for **12.75 hours**.
3. Continue to operate circulation/filtration system and maintain permitted flow rate.
4. Allow the chlorine residual to return to normal operating levels <u>on its own</u>.
5. Backwash or clean filtration system and discharge to waste after a minimum of 12.75 hours and before the pool is reopened.
6. Balance water appropriately.

Types of Disinfection Products

Inorganic Chlorine Disinfectants

Inorganic disinfectants do not contain a carbon atom, and are therefore known as unstabilized disinfectants. Unstabilized disinfectants are sensitive to UV light (the sun) and can break down more easily. These disinfectants are easily automated and controlled by an ORP system. Three types of inorganic disinfectants are: gas chlorine, calcium hypochlorite and sodium hypochlorite.

Sodium hypochlorite is a liquid chlorine that is usually 10-15% available chlorine by weight. It has a relatively short shelf life.

Calcium hypochlorite is white in color and comes in a granular, stick and tablet forms. It is 65-78% available chlorine by weight and when added to water forms a precipitate of calcium carbonate. Diluting it prior to adding it to the pool will prevent clouding of the water.

Gas Chlorine is the most dangerous of all chlorine products. It is sold in steel tanks and is a liquid under high pressure. It is 100% chlorine available by weight and is the most inexpensive chlorine available. It is rarely used because of safety concerns. When breathed in, gas chlorine can cause violent lung spasms that require hospitalization and/or death.

Organic Chlorine Disinfectants

Organic disinfectants are isocyanurics and are known as stabilized disinfectants. Cyanuric acid bonds with hypochlorous acid and prevents rapid dissipation from the sun's UV rays. It is important to remember that when the chlorine portion of the disinfectant is depleted, the cyanuric acid remains and will increase in concentration over time. As mentioned in Chapter 1, maximum cyanuric acid levels are 100 ppm in pools and 40 ppm in spas.

The most common organic chlorines are sodium dichloro-isocyanuric acid and trichloro-isocyanuric acid. Sodium Dichloro-isocyanuric acid comes in granular, tablet and stick forms and is 56-63% available chlorine by weight.

Trichloro-isocyanuric acid, more commonly known as "Trichlor" comes in tablets and granular forms. It is 90% available chlorine by weight. These are the most common tablets used in swimming pools.

It is extremely important to remember to never mix organic and inorganic chlorines. This can cause a serious explosion.

Bromine

Bromine is the other sanitizer allowed in public swimming pools. It has the same general qualities as chlorine. Bromine is impacted by UV light in a similar manner as chlorine. Cyanuric acid, however, does not protect bromine from breakdown.

The below chart describes the characteristics of the different forms of disinfectants:

	Sodium Hypochlorite	Calcium Hypochlorite	Gas Chlorine	Tri-chlor	Di-Chlor	BCDMH (Bromine)
% Available Chlorine Content	10 – 12%	65 – 78%	100%	90%	56 – 63%	27%
% Active Strength	10 – 12%	65 – 78%	100%	> 99%	> 99%	95.5%
pH in 1% solution	9 – 14	8.5 – 11	0	2.8 – 3.5	6.5 – 6.8	4.8
pH Effect in Water	Raises	Raises	Lowers	Lowers	Neutral	Lowers
Physical Appearance	Liquid	Granular, Tablet, Briquet	Gas	Granular, Tabs	Granular	Granular, Tabs

Quick Reference Guide

Dosing Requirements per 10,000 Gallons of Water

To raise Chlorine:	1 ppm	5 ppm	10 ppm
Calcium Hypochlorite	2 ounces	10 ounces	20 ounces
Liquid Sodium Hypochlorite	13 ounces	½ gallon	1 gallon
Trichlor	1 ½ ounces	7 ½ ounces	15 ounces
Dichlor	2 ½ ounces	12 ½ ounces	25 ounces

*To neutralize chlorine, use Sodium Thiosulfate: 10 ounces can neutralize 10 ppm of free chlorine in 10,000 gallons of water.

ORP and ORP Controllers

Oxidation Reduction Potential (ORP) has shown to be a monitoring parameter which takes into account numerous water chemistry components that can affect overall water sanitation. Remember, in a pool, the goal is to render contaminants invisible and non-offensive with the primary result being oxidation. However, conditions can exist which create the formation of ineffective chloramines, as well as other less desirable products. Sanitizer, cyanuric acid and pH all play a role in oxidation reduction potential.

Oxidation and sanitation in water produced by a chlorine or bromine compound result in desired clear and sanitary water. The object of the ORP controller is then to optimize the use and the control of the chlorine or bromine. This is done by measuring the quality of the process, not the quantity of sanitizer.

ORP is measured in the pool water using a sensitive voltmeter and a platinum electrode. The voltage across the platinum tip and a reference cell is called millivolts (mV) and can be directly related to the efficiency of the sanitizing agent in the water. The legally accepted range for effective sanitation in all Florida pools is 700 to 850 mV. Values below 700 become unsafe, whether in swimming pools or drinking water preparation. Oxidation suffers proportionately as ORP values drop below the 700 mV level.

The Florida Administrative Code requires ORPS on all spas, wading pools and interactive water features built after 2004. The Collier County ordinance requires ORPS on all spas (even older ones).

Guidelines Following Fecal Accidents

In the event of detected or obvious fecal contamination, the following procedures should be performed.

If the event was a <u>formed stool</u>:

1. Direct everyone to leave the pool.
2. Remove as much of the fecal matter as possible using a net or scoop and dispose of it in a sanitary manner. Clean and disinfect the net or scoop.
3. Raise the chlorine to 2 ppm (if less than 2 ppm) and ensure the pH is between 7.2 – 7.5 and temperature is about 77°F.
4. Maintain the chlorine concentration at 2 ppm, pH 7.2 – 7.5 for at least 25 minutes before re-opening the pool.
5. Notify the health department of any fecal accidents and maintain a log, recording the date and time of event, type of stool involved, the free chlorine and pH levels at the time of incident, the procedure followed in response to the accident and how long the pool was closed.

If the event was a diarrheal event:

1. Direct everyone to leave the pool.
2. Remove as much of the fecal material as possible using a net or scoop and dispose of it in a sanitary manner. Clean and disinfect the net or scoop.
3. Raise the free chlorine concentration to 20 ppm and maintain the pH between 7.2 – 7.5 and temperature at 77°F for 12.75 hours.
4. Ensure the filtration system is operating while the pool reaches and maintains the proper chlorine level during disinfection.
5. Backwash the filter thoroughly. Be sure the effluent is discharged directly to waste. Do not return the backwash through the recirculation system. When appropriate, replace the filter media.
6. Allow swimmers to re-enter the pool after the chlorine level has returned to normal operating range on its own.
7. Notify the health department of any fecal accidents and maintain a log, recording the date and time of event, type of stool involved, the free chlorine and pH levels at the time of incident, the procedure followed in response to the accident and how long the pool was closed.

How Much Liquid Chlorine to Add to Superchlorinate

	Pool Volume				
% Available Chlorine	10,000 Gallons	20,000 Gallons	30,000 Gallons	40,000 Gallons	50,000 Gallons
10%	2 gallons	4 gallons	6 gallons	8 gallons	10 gallons
12%	1.75 gallons	3.5 gallons	5.25 gallons	7 gallons	8.75 gallons

Recreational Water Illnesses: Types and Symptoms

Type	Illness	Symptoms
Fecal: Protozoa	*Cryptosporidium*	Diarrhea, vomiting, fever, abdominal pain; illness lasts 10 – 14 days; may require hospitalization, including death.
	Giardia	Diarrhea, vomiting, fever, abdominal pain; lasts 10 – 14 days; lower incidence of death.
Fecal: Bacteria	*Shigella*	Bloody diarrhea, fever, stomach cramps; lasts 5 – 7 days.
	Escherichia coli O157:H7	Severe stomach cramps, diarrhea (often bloody), vomiting; symptoms start mildly and worsen; may be life threatening.
Fecal: Viruses	Norovirus	Nausea, vomiting, diarrhea, stomach cramps; may have low-grade fever, headache, chills, muscle aches, tiredness; lasts 1 – 2 days.
	Adenovirus	Respiratory illness, gastroenteritis, eye infections, skin rashes.
	Hepatitis A	Inflammation of the liver; nausea, vomiting, diarrhea, low-grade fever, rash, fatigue, dark urine, liver pain, jaundice (yellowing of eyes and skin).
Non-Fecal	*Pseudomonas aeruginosa*	Skin rashes usually seen in armpits, groin, abdomen and areas covered by bathing suits; ear infections.
	Swimmer's Ear	Outer ear infection, causing inflammation, pus.
	Legionella pneumophilia	Similar to pneumonia, high fever, chills, muscle aches, headaches; very high death rate (up to 30%).
	Hypersensitivity Pneumonitis (HP)	Shortness of breath, coughing, fever and/or weight loss; typically occurs in indoor spas or water features.
	Methicillin-Resistant *Staphylococcus aureus* (MRSA)	
	Molluscum contagiosum	Firm bumps or open sores that are painless; may spread if bumps are scratched or injured.
	Plantar Warts	Acquired by contact with deck or locker room floor surfaces; regular cleaning and disinfection reduces infection risk.
	Athlete's Foot	Fungus causes itchy scales between toes; may grow in a ring-shaped pattern.

Chapter 4. Circulation and Filtration

Circulation

Circulation is the movement of water in the pool. Water circulation is influenced by many factors, including: inlet placement and design, circulation pumps, pool shape and contour and piping and fittings. The purpose of a recirculation system is to draw water from the pool, through a filtration system and return clean, treated water to the pool. A properly designed circulation system will provide effective removal of the surface water, which has the largest concentration of pollutants.

Florida Building Code 454.1 and Florida Administrative Code, Chapter 64E-9 require recirculation systems to be designed to allow 100% of flow through the main drain piping AND 100% of flow through the overflow gutter piping system if the main drain is blocked. If skimmers are used in place of a gutter system, recirculation flow through the skimmer(s) must be 60% of the designed flow.

Turnover Rate

The turnover rate is the time it takes for the recirculation system to move the number of gallons equal to the volume of water through the filtration equipment. Turnover rate requirements vary for different types of water use and different types of pools. This is due to pollution loads based on the type of activity and the volume of water. Turnover rate determines flow rate!

Chapter 64E-9, FAC, requires the circulation and filtration systems be operated 24 hours per day, unless on a timer, and the pool water must turnover four times per day in a regular swimming pool. In other words, one complete turnover can be accomplished every 6 hours. Many pools have one complete turnover in considerably less time than the required 6 hours. Spas are required to turnover every 30 minutes and wading pools and interactive water features must turnover every 60 minutes.

Turnover rate is calculated by the formula:

Turnover Rate (hr) = Pool Volume ÷ Flow Rate ÷ 60 minutes/hour

Example: You have a 250,000 gallon pool with a flow rate of 865 gpm. What is the turnover rate?

TR = 250,000 ÷ 865 ÷ 60

TR = 4.81 hours

Flow Rate

The proper flow rate to achieve the required flow rate is calculated by the engineer who originally designs the pool. The engineer bases these calculations on the volume of the pool in gallons. The equipment installed, especially the pumps, are chosen and installed based on the size needed to meet the required flow rate. Theoretically, if a pool is built to what the engineer designs, the equipment will perform the job it is designed to do. It is up to the operator or pool technician to ensure the equipment does work properly. This is done by regularly monitoring the rate of flow indicator (flowmeter) to be sure it remains at the proper level to produce the correct turnover.

Flowmeters are installed on the return flow line downstream of all equipment and just before the water is returned to the pool. Flowmeters are designed to read gallons per minute (gpm) and should read ½ to 1 ½ times the designed flow rate. For example, if a pool is designed for a flow rate of 100 gpm, the flowmeter should read at least 50 – 150 gpm.

Flow rate should always be maintained at or near the designed flow rate for the pool. Obstructions in water flow can decrease the flow rate. Often times, cleaning the filters and removing debris from skimmers or the hair and lint basket in the pump will return the flow to its proper levels.

Flow rate is calculated by the formula:

Flow rate = Pool Volume ÷ Turnover Rate ÷ 60 minutes/hour

Example: What is the flow rate for a 25,000 gallon pool with a 3.25 hour turnover rate?

Flow Rate = 25,000 ÷ 3.25 ÷ 60

Flow Rate = 128.20 (Round Up)

Flow Rate = 129 gpm

Filtration

Pool water is cleaned by passing through a filter. The type of material that filters the water is called media, and is comprised of sand, cartridge or diatomaceous earth (DE). Filtration is the process where the particles (bacteria, algae, debris, etc.) are captured by pores in the media or on the surface of the media.

There are two modes of filtration as well: pressure systems and vacuum systems. A pressure filter is downstream of the pump and is in a closed tank. Water is forced through the filter tank by the output pressure of the pump. As particles are trapped, there is an increase in pressure of water entering the filter and a decrease in pressure as the water exits the filter tank.

A vacuum filter is before the pump and usually in an open-to-atmosphere tank. Water is pulled through the filter media by the suction of the pump. As the media collects debris, the vacuum on the suction side of the pump increases.

Sand Filters

Sand filtration is the oldest type of filtration system, though it is not as frequently used today. Recreation pools (water parks), competition pools and large major resort pools often use sand filters. The sand used in these types of filters is typically a fine, high-grade silica sand (high-rate sand) or a combination of coarser sand and gravel (rapid-rate sand). Rapid-rate sand filters are not typically used anymore. High-rate sand filters use smaller and better quality sand. These filters typically have a long life span and must be replaced every 5 to 15 years.

Most sand filters are pressure systems, with the filter tanks being round and commonly 2 – 4 feet in diameter, though some may be up to 10 feet. Water enters the filter through the top and is spread over the top of the sand bed. It then trickles down through the sand into the laterals. Laterals allow water to pass, but if installed properly, will not allow sand to pass through. High-rate sand filters have a designed flow rate of 5 to 20 gpm/ft^2.

Cartridge Filters

Cartridge filters are the newest type of filtration system. The media is typically either polyester or treated paper in a cylindrical pleated design. Cartridge filters are typically very compact and require less room than either sand or DE filters. These filters are typically found on smaller pools and almost universally used in spas. These filter elements are considered replaceable; the normal life a commercial cartridge filter is about 6 months.

Most cartridge filters are operated in a pressure system, though there are some instances of using them in a vacuum system. The designed flow rate for today's cartridge filters is 0.375 gpm/ft^2.

Diatomaceous Earth Filters

Diatomaceous earth (DE) filters are capable of removing the smallest particles from the water. DE powder consists of tiny fossilized skeletons of small sea planktons, or diatoms. The DE powder is held against the grid device by the movement of the water. The filter grid itself is covered with a cloth-like material and the DE powder forms a coating on the cloth. DE powder can be disposed of and replaced – but it must be done so in accordance with State and local laws.

In a vacuum DE system, the filter grids are in an open tank, whereas in a pressure system, the grids are enclosed in a vertical tank. In a DE pressure system, the water inlet and outlet lines are usually located in the bottom half of the filter tank. This allows the top half to be removed for cleaning, repairing and replacing the grids. DE filters have a designed flow rate of 2.0 gpm/ft^2.

All DE filters are required to have a separation tank. When the filters are cleaned, the DE must be backwashed into the separation tank. Inside the separation tank is a cloth bag that will "catch" the DE. The water will exit through the bottom of the tank into a pipe designed to enter either the sewer or storm water system. **Used DE powder may not be discharged into the wastewater systems!** After the used DE has been collected in the bag, it can be disposed of in a regular garbage bag that has been tightly secured. **Do not dump DE powder directly onto the ground!**

When Should the Filters Be Cleaned?

Vacuum filtration systems are required to have a vacuum gauge on the line pulling water from the filter tank to the pump. When a vacuum filtration system is clean, especially for DE systems, the vacuum gauge should read no more than 8 inches of mercury (8" Hg). When starting vacuum increases by 10 inches, filters need to be cleaned.

Pressure systems must have a pressure gauge on the pipe on the inlet side of the filter, as well as one gauge on the outlet pipe from the filter. For sand filters, when the inlet pressure is 10 pounds per square inch (psi) greater than the outlet pressure, the filters should be cleaned. For cartridge filters, when the inlet pressure is 10 psi higher than the starting pressure (new or clean filters), the filters will need to be changed or clean. For pressure DE systems, the when the difference is 20 psi between the inlet and outlet gauges, the filters should be cleaned.

Filter Media Design Flow Rates

Filter Type	Filter Factor (gpm/ft^2)
High-Rate Sand	5 – 20
Cartridge	0.375
DE	2.0

Why is the water cloudy?

The following list is a reference list of factors that may cause cloudy water:

1. Failure of water treatment system and mechanical equipment
    a. Pump or chemical feeder shut-off, inoperative or drawing air.
    b. Gasket or filter element damaged, permitting filter aid to enter effluent.
    c. Filter by-passed or blocked due to failure to properly backwash.
    d. Filter media or element ruptured or by-passing unfiltered water.
    e. Filter air-bound due to inoperative air release.
    f. Pre-coat omitted after backwashing diatomite-type filter.
    g. Corrosion products or coagulants precipitating beyond filter.
    h. Backwash water discharged into pool.
    i. Use of improper chemicals or excessive dosage, or reaction between incompatible chemicals.
    j. Algae flourishing due to inadequate disinfectant.
    k. Windblown dirt due to lack of windbreak; rain water.
    l. Floating debris due to lack of inoperative skimmers or gutters.
    m. Sediment in water main stirred up by high velocity during filling of pool.
    n. Roof water or sewage backed up into pool through cross connection.
    o. Air dissolved in water or dispersed in tiny bubbles.
    p. Falling paint or ceiling materials (indoor pool).
    q. Hair strainer clogged; foreign object stuck in main drain piping.
    r. Alkalinity or pH too high or too low, causing corrosion.
    s. Scale, rust or sediment obstructing chemical feed line or instruments.
    t. Vacuum cleaner not used or unsuccessful in removing soot, dust and debris from bottom of pool.
2. Failure of bather preparation and supervision
    a. Dirt tracked in from deck or unpaved areas, street shoes on deck.
    b. Soap admitted to pool (poor showering).
    c. Bathers by-passing showers or foot sprays.
    d. Food or litter dropped into pool.

e. Bathers polluting pool or contaminating water with hair oil, suntan lotion or other cosmetics.
f. Dogs or other animals allowed to enter pool.
g. Dirty equipment such as surfboards, floats, life jackets, or scuba gear brought in from ocean or rivers.
h. Unlaundered swim suits worn by bathers.
i. Too many bathers in the pool.
j. Shower room or toilet room floors dirty or not sanitized.
k. Vandalism or sabotage.

Practice Exam Questions

1. The Florida Administrative Code _____ regulates _____ swimming pools.

2. A swimming pool used by _____ or more dwelling units is considered a public pool.

3. Records shall be kept each _____ regarding pool water chemistry and operation.

4. The pH of the water must be maintained between _____ and _____ at all times.

5. Circulation, filtration and chemical feeders must be operated _____ hours per day, unless on a timer.

6. Recirculation equipment must be capable of at least _____ complete turnovers of pool volume every 24 hours.

7. The three most important factors in balancing pool water are: _____, _____, and _____.

8. To lower pH, we may use either _____ or _____.

9. If _____ is too high, scaling and pH bounce can occur.

10. _____ and _____ are the only approved disinfectants in Florida's public swimming pools.

11. Odors and irritation are caused by chlorine which may be tied up with ammonia. These by-products are known as _____.

12. Free active chlorine in a public swimming pool should be between _____ and _____ ppm.

13. The two modes of filtration are known as: _____ and _____.

14. The rate of _____ determines whether a pool turnover is being accomplished within required time limits.

15. Swimming pool bather load is based on _____ person per _____ gallons of flow.

Conclusion

It has been the intent throughout this manual to give the public swimming pool operator the knowledge to maintain a public swimming pool in accordance with Florida law, including Chapter 514, Florida Statutes; Chapter 64E-9, Florida Administrative Code; Chapter 454.1, Florida Building Code; and Collier County Ordinances.

While many complex subjects have been covered, this manual has tried to cover these areas in a concise and understandable manner. The most important topics have been discussed, but only through continuing education and hands-on experience, will the professional pool technician gain a more complete understanding of the operation of public swimming pools.

The Florida Department of Health in Collier County staff is always ready and willing to provide any assistance you may need in ensuring the health and safety of the general public who use public swimming pools.