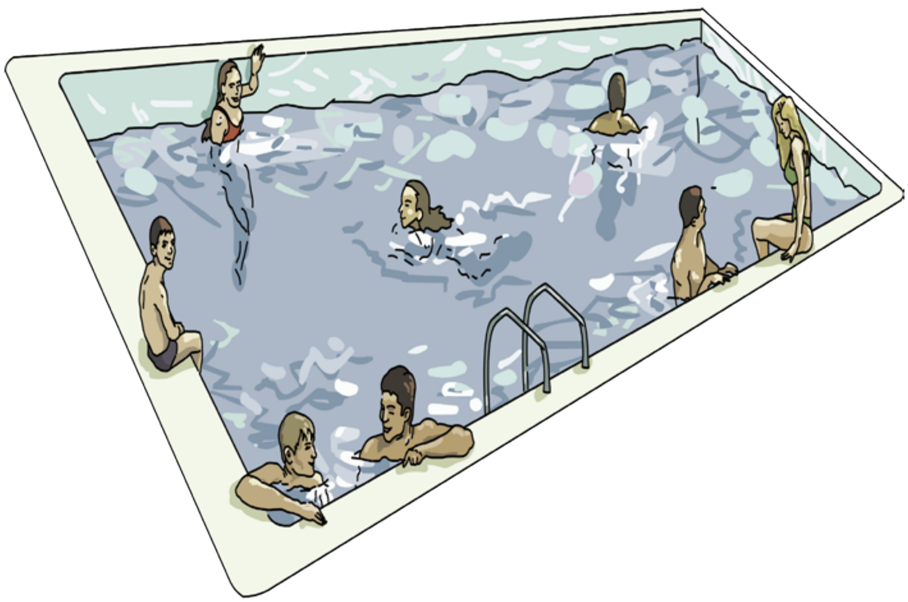
Oregon Public Health Division
Information Series:

Pool Operator Training Manual



Presented by the
Oregon Health Authority
Public Health Division
Food, Pool, Lodging – Health & Safety
&
Your County Health Department

Original is in 13 point or less. Information is also available in alternate format.
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Public Pool Program

Oregon Health Authority

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Check out our Website at:

http://public.health.oregon.gov/HealthyEnvironments/Recreation/PoolsLodging/

FORMULAS FOR POOL CAPACITY

L = length W = width V = volume D = depth

r = radius (half of the diameter of a circle)

π = (pi) 3.14 (a factor used in calculations with circles)

SURFACE AREA

Rectangular pool = L x W
Circular pool = $r^2 \times \pi$ or $r \times r \times \pi$
Right triangle = (L x W) ÷ 2

AVERAGE DEPTH

For constant slope: [D (minimum) + D (maximum)] ÷ 2 = AVERAGE DEPTH

Note: For multi-depth pools calculate the volume in sections of constant slope and add them together.

CUBIC FEET OF VOLUME (surface area times average depth)

Rectangular pool $V = L \times W \times D^{Ave.}$
Circular pool $V = r^2 \times \pi \times D^{Ave.}$

POOL GALLONAGE IN CUBIC FEET (cubic foot of water = 7.5 gallons)

Rectangular pool gallons = $L \times W \times D^{Ave.} \times 7.5$
Circular pool gallons = $r^2 \times \pi \times D^{Ave.} \times 7.5$

FLOW RATE/TURNOVER RATES

SPAS: Required turnover every 30 minutes therefore required flow rate is:

Gallons ÷ 30 minutes = minimum (min) flow rate in gallons per minute (gpm)

LIMITED USE POOLS: Required turnover at least every 8 hours (8 x 60 min = 480 min)

Gallons ÷ 480 minutes = min flow rate in gpm

GENERAL USE, LTD USE OVER 2000 SQ FT SURFACE AREA AND ATHLETIC CLUB POOLS: Required turnover at least every 6 hours (6 x 60 min = 360 min)

Gallons ÷ 360 minutes = min flow rate in gpm

HOW TO CALCULATE CHEMICALS NEEDED TO ADJUST POOL CHEMISTRY

You will need the dosage information for the chemical, i.e. the standard amount of a chemical needed to adjust a standard amount of water. This information is on the product label, or in the test kit guidebooks. The information is usually listed, for example, as "2 oz per 10,000 gallons of water to raise pH 1 ppm." This amount needs to be converted (or calculated) to be specific for YOUR pool.

Except when doing breakpoint chlorination, chemical additions should be broken down into smaller amounts. The calculated amounts are approximate, and you will want to "sneak up" on the water chemistry value you are trying to reach. Add 1/3 of the amount calculated, allow to mix, retest, then add another 1/3, and so on. Better to work up to the right reading than to over-shoot the mark and have to adjust AGAIN back down.

You want to calculate how much chemical added to the volume of water in you pool will change the chemical value the desired amount.

NEEDED INFORATION ABOUT YOUR POOL:

POOL VOLUME = amount of water in your pool
DESIRED CHANGE = amount of change that needs to take place in your pool

CHEMICAL DOSAGE INFORMATION: (Taken from the chemical label or a table.)

AMOUNT OF CHEMICAL = amount of chemical added to a:
GIVEN WATER VOLUME produces a;
GIVEN CHEMICAL CHANGE to the pool chemical parameters

So read the above 3 items as: 1.5 pounds of sodium bicarbonate (AMOUNT OF CHEMICAL) per 10,000 gallons (GIVEN WATER VOLUME) increase the Total Alkalinity 10 ppm (GIVEN CHEMICAL CHANGE).

THE FORMULA (Terms are defined above):

POOL FACTOR = POOL VOLUME ÷ GIVEN WATER VOLUME

CHANGE FACTOR = DESIRED CHANGE ÷ GIVEN CHEMICAL CHANGE

CHEMICAL DOSAGE FOR YOUR POOL =
POOL FACTOR x CHANGE FACTOR x AMOUNT OF CHEMICAL

Chemical Dosage = [14,000 gal ÷ 10,000 gal] x [20ppm ÷ 10ppm] x 1.5 lbs. Sod. Bicarb.

Chemical Dosage = 1.4 (Pool Factor) x 2 (Change Factor) x 1.5 lbs
= 4.2 lbs of sodium bicarbonate is needed in a 14,000 gal. pool to raise the Total Alkalinity 20 ppm.

WATER CHEMISTRY

DEFINITIONS:

Sanitizer: A chemical product that will sanitize or disinfect water by destroying living organisms, bacteria and viruses in sufficient numbers (99.9 %) to prevent disease.

Sanitization: Sanitization or disinfection is the process of destroying living organizms, bacteria and viruses in sufficient numbers to prevent disease. Typically we measure the processes effectiveness by looking for a 3-log (99.9 %) or 4-log (99.99 %) reduction in the number of organisms. Sanitization does not necessarily mean the destruction of all organisms.

Oxidation: Oxidation is a burning out process to convert complex organic molecules to simple compounds and eventually to a harmless gas that can escape the pool (CO_2, elemental nitrogen and others. Dust, algae, human wastes, leaves and other materials, are examples of organic and nitrogen contaminants.

Halogen: Halogen is the term used to refer to any of five elements in group VII of the periodic chart. Of the five elements, we use chlorine and bromine for pool treatment.

HALOGENS			
Group VII	**Molecular Form**	**Physical State**	**Characteristics**
Fluorine	F_2	**Gas**	Extremely reactive, Dangerous to handle.
Chlorine	Cl_2	**Gas**	Gas form dangerous, Good oxidizer, Most commonly used.
Bromine	Br_2	**Liquid**	2.25x heavier than Cl, Fair oxidizer.
Iodine	I_2	**Solid**	Stains, Difficult to handle, Poor oxidizer.
Astatine	At_2	**Solid**	Radioactive. Not Used.

Free Available Chlorine (FAC): FAC is the chlorine residual that does the sanitization and oxidation. The FAC is tested using DPD #1 and measures HOCl and OCl^-. HOCl is the active chlorine, and OCl^- is an inactive form of FAC. The ratio of HOCl / OCL^- is very dependent of the pH. At a pH of 7.2, about 2/3 of the FAC formed is in the form of HOCl. At a pH of 8.0, only about 1/3 of the FAC is HOCl with the rest as inactive OCl^-.

Combined Available Chlorine (CAC): CAC is the chlorine residual that is combined with nitrogen products such as ammonia (NH_3). The CAC is usually calculated by subtracting the FAC from the TAC. Ideally there should be no CAC in the water, or maintained as low as possible. It is very irritating at levels as low as 0.5 ppm. It is a very stable compound, but can be removed from the water by doing a "Breakpoint Chlorination"

Total Available Chlorine (TAC): TAC is the measure of FAC + CAC. It is measured by DPD #1 and DPD #3. The CAC level can be determined by subtracting the FAC (DPD #1) reading from the TAC (DPD #1 & DPD #3) reading.

Breakpoint Chlorination: Breakpoint chlorination is the process of adding sufficient chlorine to oxidize any combined chlorine and other nitrogen wastes to elemental nitrogen which gases off.

Parts per million (ppm): Ppm is a weight / weight measure equivalent to milligrams per liter (mg/l). It is equivalent to 1 pound of chemical in 1,000,000 pounds (~120,000 gallons of water)

Chlorine Sanitizers

Inorganic Chlorine Products

Chlorine Gas (Cl_2)(100% available Chorine): Chlorine gas is the most concentrated form of chlorine available. It is cheap and very effective. Unfortunately, Cl gas has been regulated almost entirely out of use for swimming pool sanitization. Chlorine gas is now a restricted pesticide, requiring special training and certification, special safety precautions and equipment, and it falls under the oversight of many national, state, and local jurisdictions. **If you presently use it, start working to switch to another sanitizer.**

Sodium Hypochlorite (NaOCl) (Liquid chlorine, bleach): Usually 10-12% available chlorine, bleach is 5.25 % available chlorine. Fairly cheap source of Cl, but will degrade over time and if stored improperly. Store in a cool, dark place. Household bleach and be used in an emergency (Do not use scented bleaches). Household bleach is half the strength and has more solids and possibly metals in it.

Calcium Hypochlorite ($Ca(OCl)_2$)(65 % available chlorine): Often referred to as "cal. hypo" or "HTH." Originally sold as a granulated powder for use as a shock, or dissolved and decanted (it forms a lot of sludge when dissolved., clear liquid has the CL.) as a liquid source of chlorine. In recent years it has also been manufactured in a "tablet" and "puck" form for use in erosion feeders designed specifically to feed cal. hypo. **DO NOT USE CALCIUM HYPOCHLORITE IN A TRICHLOR OR BROMINE EROSION FEEDER. IT WILL CAUSE AN EXPLOSION.** Some manufacturers are now placing blue specks in the calcium hypochlorite tabs and pucks. Cal. hypo stores well in a cool dry location. It can be a significant fire hazard if it gets wet, or is contaminates with other products. Do not dispose of this product in the trash. Use it in the pool, rinse and clean empty containers before placing out for trash pickup. Container disposal has been a large concern for solid waste haulers due to the fire hazard as well as toxic gas production. There may be new disposal regulations developed in the near future by the solid waste regulatory entities.

Lithium Hypochlorite (LiOCl)(35 % available chlorine): Available in a granulated powder product. Used for shocking. Product is clean dissolving and easy to use. Not used much in the pool industry because of the high cost**.** It can also be a fire hazard if stored improperly or contaminated.

Organic Chlorine Products

TriChlor (Trichloro-s-triazine Trione, Trichloroisocyanuric acid)(90 % Avail. Cl): Also known as "stabilized chlorine." And "erosion chlorine." Slow dissolving product manufactured in sticks, tablets and pucks. Made to use in a "trichlor" erosion feeder. Product comes with three Chlorine atoms attached to cyanuric acid (CYA). CYA is used as a "stabilizer " to protect the Cl from UV light degradation. CYA does not protect Cl indoors, in fact it can become a nuisance and interfere with disinfection and oxidation at higher levels. Fairly expensive.

DiChlor (Sodium Dichloro-s-triazine Trione, Sodium Dichloroisocyanuric acid)(62% avail. Cl): DiChlor has been used mainly in the laundry industry as "dry bleach." It use in swimming pools is mainly as a shock. It is fast dissolving, but adds considerable CYA to the pool, which may be undesirable. Can be a fire and Cl gas-producing hazard if wetted or contaminated.

SANITIZING WITH CHLORINE

Chlorine is the most popular and efficient sanitizer we have. If it is maintained at the required levels and the proper pH is maintained, it will kill most organisms in less than a minute. It is present in all of the sanitizing systems approved by the state for use in public pools and spas.

Whichever form of chlorine you choose to use, the reaction of the chlorine product with water will produce "**hypochlorous acid" (HOCl)**, and other by products. HOCl is the active sanitizer and oxidizer. You test HOCl as **Free Available Chlorine (FAC)**, using your test kit and DPD #1, if you have a color comparator kit, or your DPD powder and using the titrating solution if your have that type of test.

Sanitizing the Water

The HOCl will react with organisms in the water and kill them. We are particularly interested in killing those that could cause swimmer illness. Typically, little of the chlorine in the pool is needed to kill the microorganisms. With the exception of some protozoan organisms (*Cryptosporidium, Giardia, Cyclospora)*, most organisms will be killed by very low levels of chlorine in very short periods of time (seconds to 1-2 minutes).

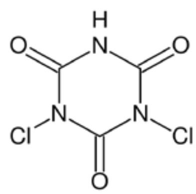
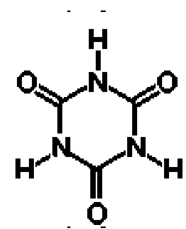
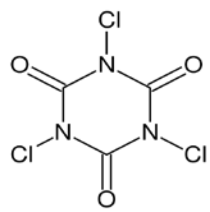
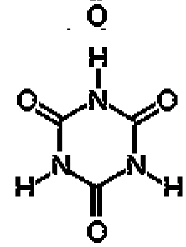
HOCl will react with the bacteria, viruses, protozoa, algae in the water and will kill or eliminate them. It also reacts with the oils and greases, leaves, dead bacteria, skin particles and other organic contaminants, to "**oxidize"** (breakdown or burn up the organic materials) and eliminate them from the water.

The oxidation process can be compared to burning a pile of leaves. They don't burn quickly and create lots of smoke. If we put a box over the pile of leaves, the box will fill with smoke, and because the fire cannot get fresh air, the fire will go out.

A similar burning process in the swimming pool, creating a gas-off product (nitrogen trichloride – a form of combined chlorine or chloramine) that is irritating like smoke causing red burning eyes, coughing, and nose and throat irritation. At most outdoor pools the smoke is blown away and with lots of fresh air, the oxidation can continue, so we find few problems with chloramines or combined chlorine. Indoor pools, like the pile of leaves with the box over the top, trap the "smoke" causing swimmer discomfort, and the lack of fresh air causes the oxidation to stop before everything is oxidized. Many times it is almost impossible to get rid of all the combined chlorine at an indoor pool.

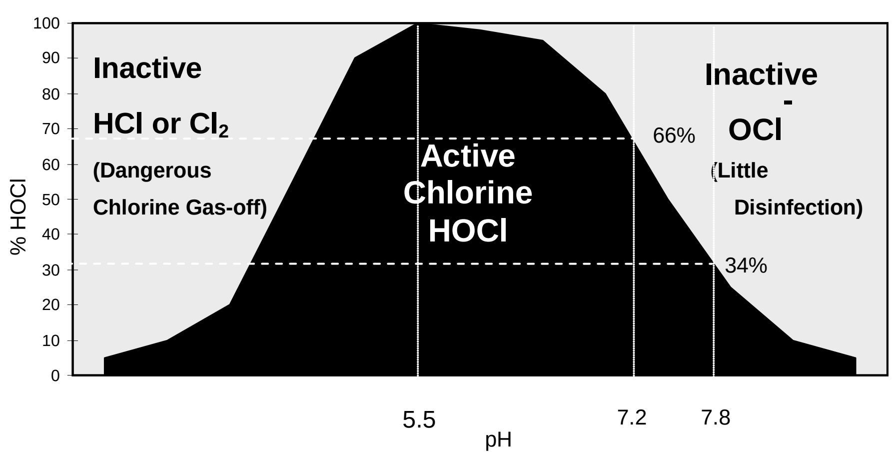
It is very important to get lots of fresh outside air into the pool area by opening windows and doors and adding fans to blow across the water.

Chlorine Products and Their Reaction When Added to Water (H_2O)

Chlorine Gas	**Cl_2**	**+**	**H_2O**	→	**HOCl**	**+**	**HCl**
Sodium Hypochlorite **NaOH**	**NaOCl**	**+**	**H_2O**	→	**HOCl**	**+**	
Lithium Hypochlorite	**LiOCl**	**+**	**H_2O**	→	**HOCl**	**+**	**LiOH**
Calcium Hypochlorite **$Ca(OH)_2$**	**$Ca(OCl)_2$**	**+**	**H_2O**	→	**2HOCl**	**+**	
Sodium DiChlor		**+**	**H_2O**	→	**2HOCl**	**+**	
TrI-Chlor		**+**	**H_2O**	→	**3HOCl**	**+**	

Hypochlorous Acid

The amount of hypochlorous acid (HOCl) formed in each reaction is dependent on the pH of the water. Low pH will form more HCl and Cl gas, pH at 5.5 forms almost totally HOCl and as the pH increases lower amounts of HOCl are formed and increasing amounts of OCl^- are formed. OCl^- is inactive as a disinfectant



% of HOCl Formed at Various pH Values

Combined Chlorine (Chloramines)

Combined chlorine is the reaction of “hypochlorous acid” (HOCl) with nitrogen containing compounds, particularly ammonia (NH_3). Depending on the chlorine concentration, the pH and the temperature the hypochlorous acid / ammonia mixture will form one of three compounds.

Monochloramine	NH_2Cl	
Dichloramine	$NHCl_2$	
Trichloramine	NCl_3	(Also known as Nitrogen trichloride)

With enough free chlorine and adequate ventilation to blow away the breakdown products that gas off the pool, the chlorine will break down the ammonia products until nitrogen is all that is left, which gases off the pool.

Unfortunately the process seldom goes perfectly. Often we get a lot of trichloramine (NCl_3) which is an oily substance that volitalizes out of the water into the air. Nitrogen trichloride is the cause of most of that “swimming pool” smell. It can be highly irritating and is the cause of the lung, eye and throat irritation people experience in poorly ventilated indoor pools.

To combat the buildup of chloramines the operator can use chlorine to breakpoint chlorinate the pool, use a non-chlorine oxidizer (potassium or sodium monopersulfate), use ozone, install medium-pressure UV light treatment, or increase the ventilation and air blowing across the pool. The last three treatments are costly methods of controlling chloramines, and are only practical on larger pools, although most pools can increase ventilation for short periods by using fans and opening outside doors or windows.

Breakpoint Chlorination:

Breakpoint chlorination is a calculated process. The amount of combined chlorine / chloramines in the pool must be known. If we take the amount of combined chlorine in ppm and multiply that by 10, we can determine how much new chlorine to add to the pool to reach breakpoint.

Example: You test the pool and find 2 ppm combined chlorine:

2 ppm x 10 = 20 ppm of new chlorine that must be added to the pool to reach breakpoint

Breakpoint Chlorination

To achieve breakpoint
you must add an
amount of new free chlorine equal to
10x
the combined chlorine level

Water Balance

"Water Balance" is the process of maintaining the water in a state that is neither non-scaling nor corrosive. It is comfortable for the swimmers and easy on the pool equipment and pool surfaces.

To achieve this, the pool must be maintained at the "calcium saturation level." This means that the amount of calcium dissolved in the water is the maximum amount the water will hold without any precipitating out. We can calculate this using the **"Langelier Index"** found in this document.

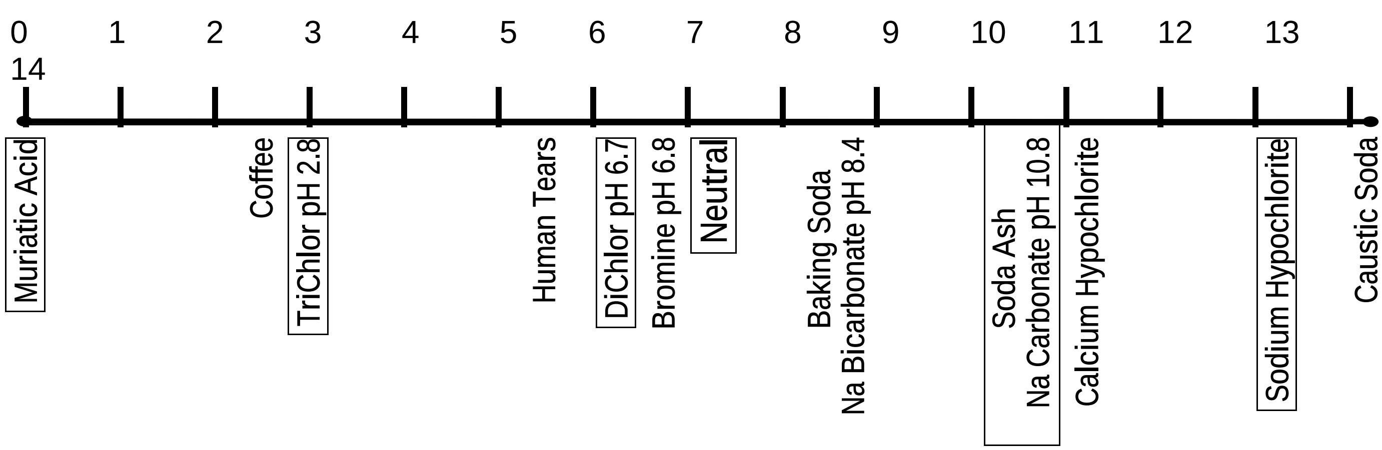
You can think of water that is not saturated with calcium as "hungry," it will look for something to satisfy its hunger causing corrosion of the pool surfaces and eating away at the metal components of the recirculation system. If it is "overfed," the excess calcium is deposited as scale on surfaces and can cause cloudy water as the calcium comes out of solution.

To determine "calcium saturation," or "water balance," we look at the relation of 5 different measurements of the water. These factors are:

- pH
- Total Alkalinity (TA)
- Calcium Hardness (CH)
- Temperature of the Water
- Total Dissolved Solids (TDS)

pH

pH is technically the "negative logarithm of the hydrogen ion (H^+) concentration." In simpler terms it is how "acidic" or "basic" a solution is. It is based on a scale from 0 to 14 where the lower the number the more acidic the solution.



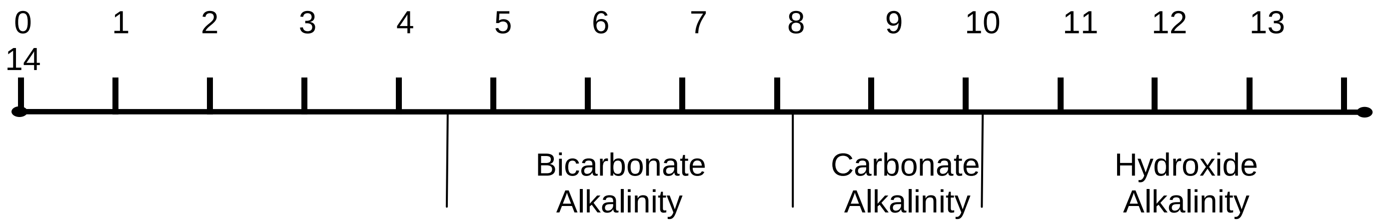
Lower pH:
Muriatic Acid
Sodium Bisulfate (Dry Acid)
Carbon Dioxide (CO_2)

Raise pH:
Caustic Soda
Soda Ash
Baking Soda

Total Alkalinity (TA)

Total alkalinity is the measure of how stable the pH is. It measures the pool water's buffering capacity to resist pH changes. Without control of the total alkalinity, the pH will rise and fall abruptly. The ability to resist this change in pH is due to the presence of bicarbonate and carbonate ions and other compounds.

Main Type of Total Alkalinity (Buffer) Compounds According to pH



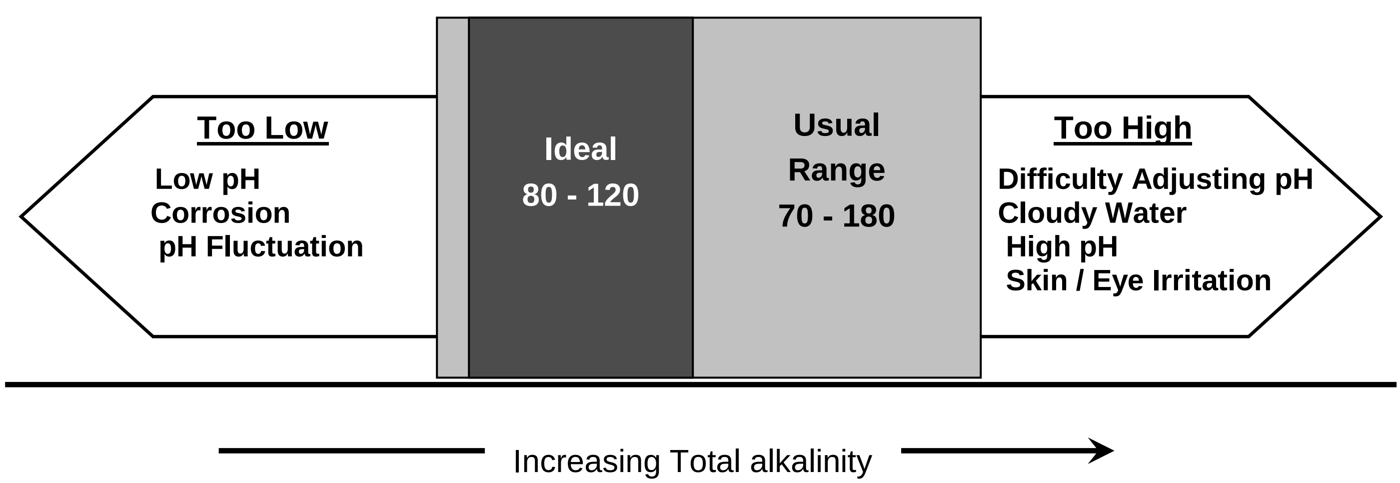
In general, total alkalinity should be kept between 80 ppm and 140 ppm but this will vary from region to region. The ideal reading for alkalinity will vary due to three variables: (1) type of pool, (2) type of sanitizer, and (3) type of shock.

When alkalinity is either too high or too low, water acts much like that with a low pH or high pH level.

A low total alkalinity makes it difficult to maintain a desired pH and can lead to corrosive water, which can damage equipment. Green water can also be another symptom of low total alkalinity. To increase the alkalinity level, add sodium bicarbonate, typically packaged as "Alkalinity Increaser", "Alkalinity Up", or "Alkalinity Plus". Always read the instructions on the label before adding any type of chemical, as manufacturers will recommend varying amounts to add per 10,000 gallons of water as well as the specific procedures.

High levels of total alkalinity can cause the pH to "get stuck" and is difficult to change. High Total alkalinity can also cause cloudy water and scale formation. To decrease the alkalinity level, sodium bisulfate or muriatic acid can be added to the pool water – these are the same chemicals used to lower pH. Always read the instructions on the label before adding any type of chemical, as manufacturers will recommend varying amounts to add per 10,000 gallons of water as well as the specific procedures.

Proper Range for Total Alkalinity



Calcium Hardness

Calcium hardness testing is a measure of the hardness minerals in the water. There are several, but the most important is calcium, and hardness, when tested with your pool test kit, is reported in equivalence to $CaCO_3$.

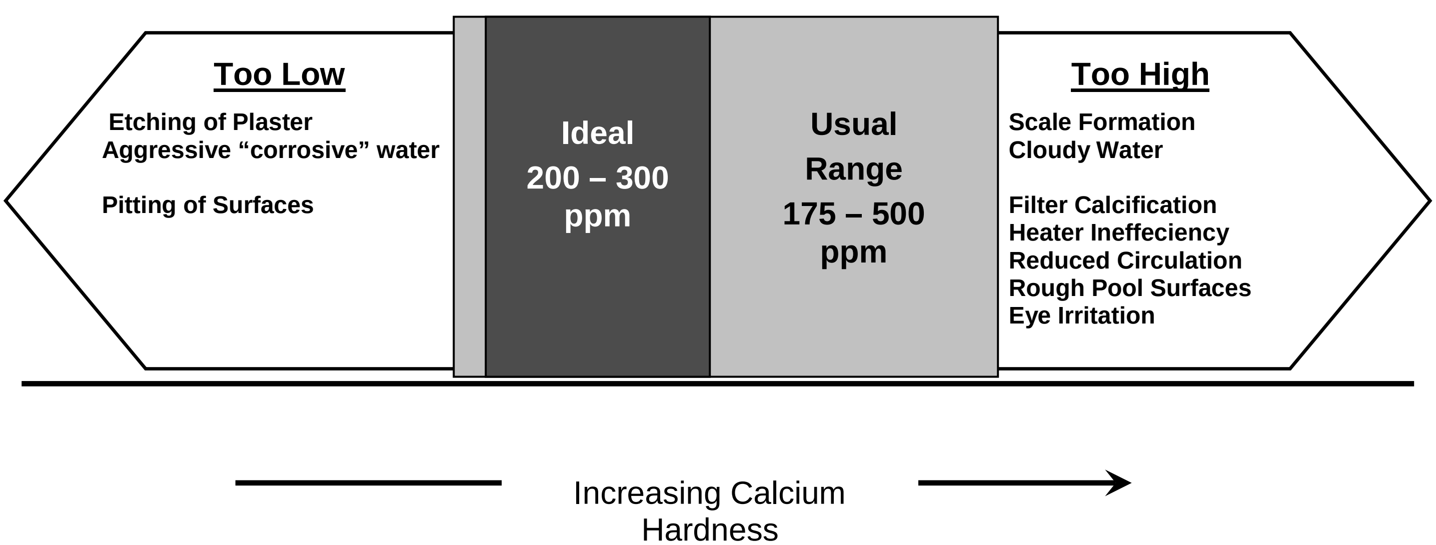
Potable water supplies in most of Oregon are in the range of 40 – 60 ppm calcium hardness. This is considered "very soft." There are a couple of areas in the state where hard water can be encountered; mainly in the Hermiston / Pendleton area. In this area some of the potable water is considered very hard with several hundred ppm calcium hardness, depending on the source.

Soft water is good for washing or when soap is used, as the soap does not form a sticky layer of soap & minerals on the water's surface, hence "hard water." In soft water the soap foams well and clothes usually stay whiter.

In pools, we are concerned with maintaining the pool surfaces and equipment. We are attempting to maintain water that is saturated with calcium to prevent the corrosion of the surfaces and equipment. However, we don't want so much calcium that is will not all stay dissolved in the water, "scaling" out on pool surfaces and inside equipment and piping. Scaling can make the surfaces rough and actually plug piping with calcium scale. Watch your pool heater.

To maintain calcium saturation we must consider the calcium level as well as pH, total alkalinity, temperature and total dissolved solids.

Proper Range for Calcium Hardness



Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are a measure of all the stuff dissolved in the water that would be left in a sample if the water was removed. Sort of like the stuff left when a teapot has been reheated and the water evaporated.

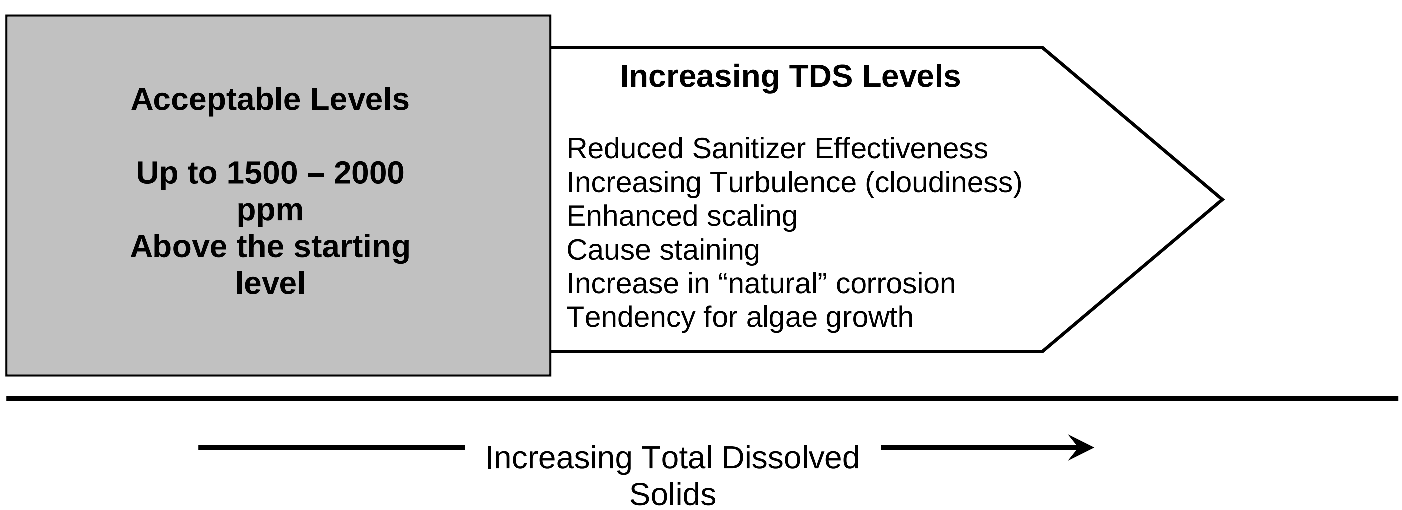
The solids are made up of minerals, organic materials, oils, and other material in the water. Most anything that is added to the water contributes to the total dissolved solids, especially the swimmers.

Potable water usually has about 100 ppm (TDS). As the water ages the TDS climbs until we can think of the water as crowded with dissolved material. This condition makes it hard to disinfect and control the water quality in the pool. Usually we will drain the pool and replace the water when the TDS becomes this high by either draining all the water, or diluting the pool with repeated partial drain and refills.

With salt water pools, the pools start off with TDS levels close to 3500 ppm. We would begin to dilute and drain these pools once the TDS climbed about 1500 ppm over what it was to begin with.

TDS is tested by using a conductivity meter. Pure distilled or completely deionized water will not conduct electricity. As minerals and things are dissolved in the water the water will conduct electricity better and better. The conductivity meter will measure this and relate it to the TDS levels.

Total Dissolved Solids



Temperature

Temperature is a real concern when dealing with calcium saturation because calcium carbonate, the most common form of calcium, is more soluble in colder water. This is contrary to what we find with most other materials we can dissolve in water.

The concern is the warmer the water the lower the calcium hardness needs to be to be at saturation, so spas do not need as high a level of calcium. The other concern is where the pool is winterized during the colder weather. If the calcium isn't adjusted for the cold water temperatures, the pool basin can suffer from the corrosive water

For most of us, we have little control over the temperature. The public likes swimming in water of a certain temperature depending on the activity. We cannot cater to each group without greatly increasing the heating costs. Most operators find a median temperature and leave it there when the pool is open for swimming.

Common temperature preferences:

Polar Bear Club – usually 45 – 60^{o} F
Serious Lap Swimmers – about 78^{o}F
Recreational Swimmers – about 82 – 84^{o}F
Classes (children) – about 86 – 90^{o}F
Older Exercisers – about 86 – 95^{o}F
Spa Users – (Hotter is better) Do not exceed 104^{o}F Recommend 102^{o}F

Our regulations only regulate spa temperatures. At this time the rules allow a maximum 104^{o}F. Over the years we have found that this temperature can be harmful to some people. It is our strong recommendation that spas be maintained at no more than 102^{o}F. At some point the rules will be updated with this temperature.

The lower temperature is much safer for pregnant women, older users, persons using the spa while intoxicated (not recommended) and for small children (not recommended). Studies have shown that most people cannot sit in a 104^{o}F spa for more than 15 minutes without risking the chance of overheating. Most people can sit in a spa at 102^{o}F for much longer periods of time without health effects.

The Langelier Index

The Langelier index is one of several methods of calculating calcium saturation in your pool. Your pool test kit has a device to also test for calcium saturation. Another of the other popular methods of calculating the saturation is the "Rysnar Index"

All the indexes use the pH, total alkalinity, calcium hardness, temperature and total dissolved solid levels in your pool. The relation of these allows us to determine the calcium saturation.

The langelier index, used here, is one the health departments will most often use.

The calculation uses the pH of the water as is, and adds factors off the table below for total alkalinity, calcium hardness and temperature. Total dissolved solids do not change the calculation much, and are often used as a constant of -12.1. If the TDS is over 1000 ppm the constant can be changed to -12.2.

The formula for calculating the calcium saturations is:

Saturation Index = pH + TF + CF + AF – 12.1

Where:

pH = pH | **CF = Calcium Factor**

TF = Temperature Factor | **AF = Alkalinty Factor**

Temperature		Calcium Hardness		Total Alkalinity	
^{o}F	= TF	ppm	= CF	ppm	= AF
32	0.0	5	0.3	5	0.7
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	1.8	150	2.2
76	0.6	200	1.9	200	2.3
84	0.7	300	2.1	300	2.5
94	0.8	400	2.2	400	2.6
105	0.9	800	2.5	800	2.9
Too	Hot	1000	2.6	1000	3.0

Values between +0.5 and -0.5 are consider balanced

Negative values are <u>corrosive</u>

Positive values are <u>scale forming</u>

Chemical Dosages

Using the formula found on page two of this packet, you can use the following dosages to figure out how much chemical you will need to make changes to you water chemistry. Remember, “breakpoint chlorination” requires that the entire calculated amount be added at once. All other chemical parameters should be adjusted slowly by breaking up the dosage calculated into smaller additions to add to the pool, allowing mixing between additions.

Chemical Dosages

Product	Amount per	Gallons	= Amount of Change	Effect on pH
Raising Chlorine Residuals				
Gas Chlorine (Cl_2)	1 lb.	12,000 gal.	12 ppm	↓↓
Sodium Hypochlorite (10 % liquid chlorine)	1 gal.	12,000 gal.	12 ppm	↑↑
Calcium Hypochlorite	1.5 lbs.	12,000 gal.	12 ppm	↑↑↑
Lithium Hypochlorite	3.25 lbs.	12.000 gal	12 ppm	↑↑
TriChlor (Stabilized Chlorine)	Not used for hand dosing the pool. Use only in an appropriate feeder.			↓
DiChlor	Not recommended for hand dosing the pool.			↓
Lowering Chlorine Residuals				
Sodium Thiosulfate	1 lb.	10,000 gal	10 ppm	↑
Raising Total Alkalinity				
Sodium Bicarbonate (Baking Soda)	15 lbs	10,000 gal	10 ppm	↑
Raising Calcium Hardness				
Calcium Chloride (Flaked or Pellets)	11 lbs	10,000 gal.	10 ppm	
Lowering Total Alkalinity				
Muriatic Acid or Dry Acid (Sodium Bisulfate)	The best way to adjust is to add dilute acid evenly around the pool. The initial effect will be a decrease in pH, but as the water gets agitated or aerated, the total alkalinity will decrease. Add small amounts daily until the desired level is reached.			↓↓
Lowering Calcium Hardness				
Drain some water and refill with fresh water with lower calcium hardness				
Lowering Cyanuric Acid Levels				
Drain some water and refill with fresh water.				

DHS
Oregon Department of Human Services

Oregon Public Health Division
Public Pool & Spa Program
(971) 673-0448
www.oregon.gov/DHS/ph/pl

Oregon
Ideal Pool and Spa Parameters

Parameter	Pools			Spas / High Temp. Pools			Wading Pools		
	Min.	Ideal	Max.	Min.	Ideal	Max.	Min.	Ideal	Max.
Free Chlorine w/ Cyanurates or ORP Reading	0.8 ppm 0.8 ppm 750 mv	1 – 3 ppm 2 – 4 ppm 750–800mv	5 ppm 5 ppm ~850 mv	1.5 ppm 1.5 ppm 750 mv	3 – 4 ppm 4 – 5 ppm 750 - 800	5 ppm 5 ppm ~850 mv	2 ppm 2 ppm 750 mv	3 – 4 ppm 4 – 5 ppm 750-800	5 ppm 5 ppm ~850 mv
Combined Chlorine	0	0	0.5 ppm	0	0	0.5 ppm	0	0	0.5 ppm
Bromine	3 ppm	3 – 5 ppm	10 ppm	3 ppm	4 – 6 ppm	10 ppm	Not Recommended Not allowed on Spray Pools		
Cyanuric Acid Outdoor Pools Indoor Pools	0 0	20–30 ppm 0	150 ppm 150 ppm	0 0	0 0	150 ppm 150 ppm	0 0	20-30 ppm 0	150 ppm 0
pH	7.2	7.2 – 7.4	7.6	7.2	7.2 – 7.4	7.6	7.2	7.2 – 7.4	7.6
Total Alkalinity	70 ppm	80-120 ppm	180 ppm	70 ppm	80-120	180 ppm	70 ppm	80-120 ppm	180ppm
Calcium Hardness	175ppm	200 – 300		175ppm	200-300		175ppm	200 - 300	
Total Dissolved Solids		100 – 2000			100-2000			100-2000	
Iron		0			0			0	
Copper		0	1 ppm		0	1 ppm		0	1 ppm
Clarity	Ideal – Crystal Clear Minimum – See main Drain			Ideal – Crystal Clear Minimum – See main Drain			Ideal – Crystal Clear Minimum – See main Drain		
Temperature	70^o F	78 – 85^{o}F	90^{o}F	~90^{o}F	90-102^{o}F	104^{o}F**	75^{o}F	78-88^{o}F	90^{o}F

** **The Department strongly recommends keeping spa temperatures 102^{o}F or lower.**

This document is available in alternative formats. Contact (971) 673-0448 for assistance (Revised 02/07)

Diseases and Sanitation

There are a variety of diseases that are of concern in swimming pools and spas. Many of the more serious are gastrointestinal in nature causing diarrhea, vomiting, abdominal pain, fever and malaise. Diseases can also be spread by, and infect the nose, eyes, ears, genitals, skin and wounds.

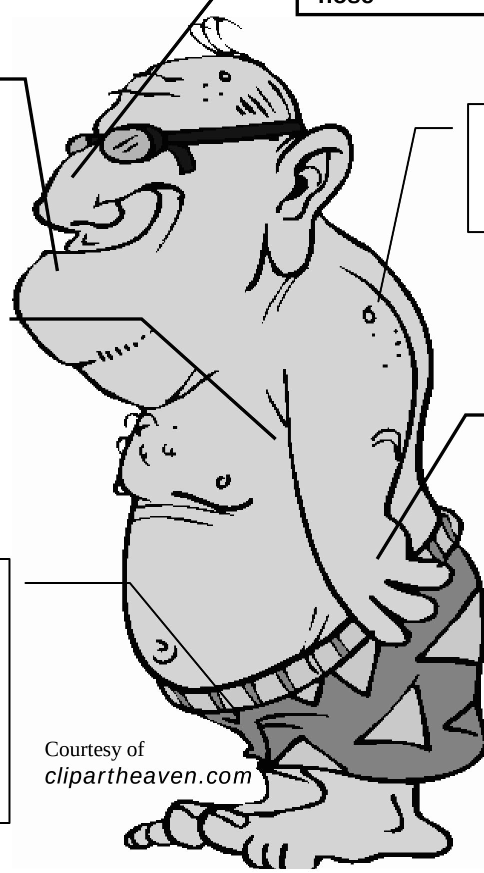
Intestinal Diseases – Shigellosis, E. Coli, Giardiasis, Cryposporidiosis, Cylosporidia and others can be spread by swallowing the disease organisms after they have been excreted by the carrier. Most microorganisms are very susceptible to chlorine disinfection, though some have shown remarkable resistance. Most important is to avoid swimming if you have had diarrhea within the last two weeks. Thorough showering can also help.

Respiratory Diseases – Colds, Strep throat, Pseudomonas, and Legionellosis can be readily transmitted by persons having these diseases. Prolonged contact with the water can remove protective coatings in the respiratory tract making a person more susceptible to infection

Eye, ear, and skin infections – Athlete's foot, granuloma, impetigo and pinkeye are some of the more common infections that can be transmitted from one person to another. In addition to the pool water, transmission can occur because of dirty floors, seats, counters swim suits, towels, rough surfaces and combs.

Pseudomonas Auriginosa – is one of the most common skin infections with transmission usually occurring in spas. The organism can be easily passed between bathers because of the large amount of chlorine used up when several people are in a small volume of water like a spa. Showering is a good preventative measure for preventing transmission. Pseudomonas can causes serious respiratory eye, and ear infections.

Aids and Herpes Viruses – These Viruses are not usually associated with transmission in public pools during normal swimming activities. They are sexually transmitted.



Diseases and Sanitation (con't)

As the pool operator, you can affect the behavior of the swimmers using your pool. One of the most important pieces of prevention is educating the users of your pool as to what is expected from them as far as personal hygiene. If you expect showering, you will usually get better compliance than if you ignore it.

Some pools have used signs, newsletters, educated their lifeguards and staff and used them for public education, and other methods of public education. Our staff and local health department staff are occasionally available as speakers at public meeting of users or pool operators to pass on hygiene and disease prevention information.

Education Highlights:

1. **Do Not Come To The Pool If Ill**. If a swimmer has a contagious illness, or have had diarrhea within the last two weeks they should not come swimming. This is especially true for small children.

2. **Take a Shower.** Proper showering can reduce the bacterial and soil loading on the pool by as much as 50%. Proper showering is a nude shower using soap.

3. **Make sure your children take bathroom breaks.** An hourly break is usually a good idea to prevent accidents in the pool.

4. **Change diapers in the designated changing area.** Changing diapers on the pool deck or on tables or chairs spreads microorganisms over large areas in the pool area where others will come in contact with it. (yukkk) !

5. **Make sure pool staff know how to properly handle fecal accidents.** In addition to helping prevent the spread of disease organisms, proper handling will help satisfy your customers that you take contamination of the pools seriously.

6. **Don't slather up with suntan oils and moisturizers just before going in the pool.** Most suntan oils and moisturizers will wash off quickly in the pool, causing a tremendous load for the disinfectant to deal with. The best approach is to shower immediately after leaving the pool and then applying the suntan oil or moisturizer. They are more effective that way. Perfumes and aftershaves will also wash off and can be smelled and tasted in the water.

7. **Discourage street shoes and clothes in the pool area.** Shoes particularly can sometimes track large amounts of dirt and contamination into the pool area. Best if they are left outside the pool area if there is a secure area.

Operators that have been proactive and consistent in educating and enforcing these concepts actually have good compliance. It takes effort on the part of you and your staff, but the reduced risk of disease transmission can be significant. It also helps make people think about proper hygiene and safety when they are using other pools and other recreational bodies of water.

Diseases and Sanitation (con't)

What can you do to make sure your pool is sanitary?

1. **Maintain sanitizer residuals.** Test the water whenever you are open for operation. One test a day is insufficient. Use the rules as your guide. Consistent and adequate sanitizer levels will really help make your pool safe.

2. **Make sure the recirculation equipment is operating properly.** Inadequate filtration and water circulation can be a real problem. Maintaining clear water helps remove disease organisms, and clarity is an important safety concern. DO NOT operate you pool if you cannot clearly see the main drain.

3. **Clean the decks daily.** At many pools a daily rinse with potable water is sufficient for normal operation. At least once per week, the deck should be scrubbing with a stiff bristled broom and disinfectant. Outdoors allowing the deck to dry completely in the sun is a very good way to keep it disinfected. Cleaning with a disinfectant will remove oils and dirt. The best disinfectant is chlorine. Make sure whatever you use is food grade and compatible with the pool water chemistry. Floor cleaning machines are not always appropriate for cleaning as they can spread dirt and disease organisms.

4. **Clean and disinfect the locker rooms daily.** Allowing them to dry out is very important. Consider using fans or increasing ventilation if drying is a problem. Again, most locker rooms can be scrubbed using a bristle broom and sanitizer. Be sure garbage cans are emptied and that you use a liner to keep them clean. Scrub toilets, urinals and sinks daily. The best locker room can be cleaned and rinsed using a hose. All surfaces are waterproof, drained, and easily rinsed.

5. **Check locker rooms periodically during the day.** Often busy pools run out of soap, paper towels, and other hygiene supplies. Sometimes things back up or vandalism occurs causing the locker room to need immediate cleaning. Stay on top of these problems. A clean, well-maintained locker room is a good advertisement for your facility.

6. **Keep records of your efforts.** When things happen, having records of when areas were cleaned or locker rooms were checked can be important. Water testing results should be available to the public upon request. There should not be any reason your do not want to show off your exemplary operation.

Be proud of your facility and what you do. Encourage your staff to feel the same. Remember this is <u>your</u> facility and it reflects on your sense of pride and workmanship. Keeping a top notch facility is usually the best way to make a safe and healthy facility. Operating a pool is a complicated and demanding job and doing it well is worth feeling good about.

Care of Seasonal Pools

Closing a pool, preparing it for winter conditions, and opening it again in the spring requires special techniques. Methods of seasonal care may vary according to the winter conditions and past experiences. The two greatest concerns are freezing and hydrostatic pressure. The first can crack pool fittings and piping; the second can cause the pool to rise out of the ground (float), damaging recirculation lines and systems and often damaging the pool basin beyond repair.

A successful winterizing program prevents rust, moisture accumulation, and general deterioration resulting from nonuse. Rodents and insect can enter a closed facility if care is not taken to prevent their entry. Vandalism is one of the pool operator's greatest concerns and any winterizing schedule must include adequate security plans.

Protecting the Pool:

The pool basin is the largest exposed area to be winterized and protected against vandalism. An empty pool's surface, whether painted or tile, is subject to weather conditions if left exposed. In addition an empty pool is susceptible to floating if the groundwater gets high enough. Most pools should be winterized with water in them, unless provisions have been made to remove excess groundwater under the pool. A pool that is covered and filled will be protected best from the elements.

Pool Blankets:

Since the pool is protected best by covering it, many pool operators use pool blankets. These blankets are designed not only to conserve energy, but also to protect the pool from winter problems. They need to be secured in the corners and along the sides to prevent the wind from lifting them and blowing them off.

Pool blankets should never be considered as safety devices. A person or animal that falls into the pool will quickly become entangled in the blanket. Eliminating pool access to unauthorized persons is still required for control. A very good second layer of protection against someone or something getting in the pool would be a security cover that can be attached around the edges to the deck and locked on so they cannot be removed by unauthorized persons.

Pool Recirculation and Chemistry:

A pool placed on a recirculating schedule for 4 hours out of 24 is recommended. A covered pool will need minimal chemicals to maintain its balance. Deterioration costs of an emptied pool can easily justify a covered and recirculated pool.

Pool Expansion;

The danger of the pool basin being damaged from expansion due to freezing is minimal. The same cannot be said for the piping, fittings associated with the pool. Freezing can often be avoided, even during extremely low temperatures if the pool is covered and recirculated 24 hours a day.

In areas with long periods of freezing temperatures the piping system is commonly drained and capped, then treated with a non-toxic antifreeze solution. If this is done, it is a good idea to remove the pump and store it in a warm location. Winter is an excellent time to service the pump so it is in top notch condition in the spring.

Filtration

Definitions

Biologically Clean water - Water that is free from harmful bacteria

Physically Clean Water - Water that is free of particulate matter; suspended particles which make the water turbid (cloudy)

Flowrate / Recirculation Rate - The rate of water- flow through the recirculation system, usually expressed in gallons per minute (gpm)

Turnover Time - The amount of time required to move a volume of water, equivalent to the pool volume, through the recirculation system

Pools:
Turnover time (hrs.) = Pool volume (gal.)/(60 X flowrate (gpm))

Spas:
Turnover time (min.) = Volume(gal.)/ Flowrate

Gage & Bidwell Chart

Number of times a volume of water equivalent to the pool volume is filtered	Percent of dirt removed by cumulative filter runs (after reaching equilibrium)
1	42%
2	84%
3	95%
4	98%
5	99%

Turnover Rates

Public Pools:	5 - 6 hrs
Heavy Loads:	3 - 5 hrs
Spas:	20 - 30 min
Heavy Loads	10 min or less

* A filter is more efficient as it becomes dirty
* 25 microns = 1/100th of an inch

	SAND	DIATOMACEOUS EARTH	CARTRIDGE
Initial Cost	Medium	High	Low
Filter Media Replacement Cost	No Cost	Average	Very High
Clarity	(25 - 100 microns)	Excellent (4 - 6 microns)	Very Good (10 -25 microns)
Backwash Necessary	Yes	Yes	No
Flow (gpm / minute / sq. foot)	Rapid Rate 1 -3 gpm	1 - 2 gpm	0.375 gpm
	High Rate 4 - 20 gpm		

Sand Filtration

Sand filtration is the oldest of the different types of filtration. It has developed thru several stages and types of filters.

Gravity sand – Is the earliest type of sand filter. The sand was deposited in a tank in graduated sizes from fine sand to pea gravel to larger sizes of gravel. The water during the cleaning of the filter would distribute the sand so the finest particles were towards the top of the tank. Filtration occurred as water was introduced on top of the sand and allowed to flow through the sand with the aid of gravity. Flow through the sand was about a maximum of 1.5 gpm./ sq. ft. of filter surface area. Filters were very large.

Rapid rate sand – Was fast campared to the gravity. The water was pulled or pushed through the sand and gravel. At 2 – 4 gpm / sq. ft.. these were much faster and required less than half the surface area needed for the gravity sand. Still very large. Filtration occurs at the surface of the sand.

High rate sand – Was developed during WWII when clean drinking water needed to be provided to the troops but large tanks were impractical to move around. Today's high rate sand filter has a sand bed made up of typically #20 silica filter sand. This sand has jagged edges, so does not pack down tightly allowing the water to run through easily, but trapping the dirt. These filters use about the top 6 inches of the sand for filtration. Almost all filters now days are high rate sand filters. Flow rates vary from 5 – 20 gpm / sq.ft. of filter surface area

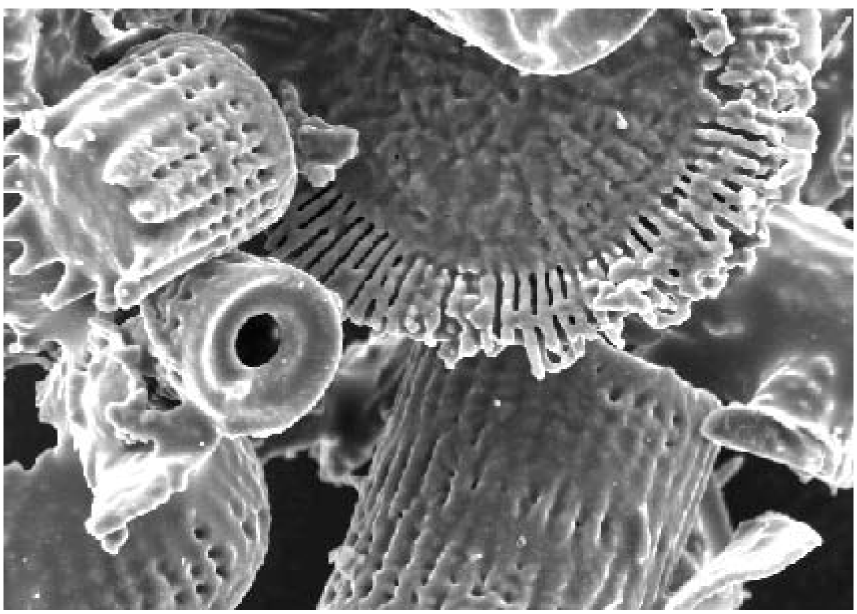
Backwashing – Is the process of cleaning a sand filter. The water flow is reversed through the filter at a rate of about 12 -15 gpm / sq.ft. of filter surface. This flow is enough to lift the sand particles and allow the dirt to be washed out, but not so much the sand is washed out as well.

How long will the sand last? There are still some gravity sand and rapid rate sand filters still using their original sand after many, many years. However, the high rate sand filter seems to require occasional sand replacement. Usually the sand becomes coated with oils and greases that trap dirt onto the sand particle. If the sand is thoroughly cleaned routinely, the sand can last for years. As a usual rule though, most pools need to change their sand about every 5 years with regular care.

Diatomaceous Earth (D.E.)

Diatomaceous earth filtration is a type a filtration with "replaceable media," as compared to "permanent media" that is not replace like sand and cartridge filtration. With DE filtration, once the DE as collected enough dirt, we will backwash or clean the filter and remove all the dirty DE. We replace it with clean DE which is coated onto a filter bag, and the filter run begins again.

Diatomaceous earth is the silica-based skeletons of one-celled organisms called "diatoms" (see the picture). The organisms lived in warm shallow seas and when they died, huge layers of them were left behind when the seas dried up. They look like little sieves, and the water flows right through the skeleton. The holes in the skeleton are small enough the most dirt and bacteria will not flow through them and are trapped.



Greatly Magnified Diatoms

DE filters are used to filter fruit juices and beer products. DE is also an EPA registered insecticide, a frequent ingredient in toothpaste and scouring powder and has many other uses.

DE is a fine, white, floury powder when dry. It can be a health hazard if the dust is inhaled. It should not be handled dry.

Diatomaceous Earth (D.E.) Filtration

DE filters use diatomaceous earth to filter out the particulate matter in the water. DE provides the best filtration of the three types of filters addressed in this booklet. A good filter run will filter out particles as small as 2 microns. This makes the DE filter effective at removing cryptosporidium oocysts, one of the pool operator's more difficult to handle disease-causing organisms.

To work, a DE filter has what are called "septums." These are support structures that come in a variety of shapes and sizes which are covered with a "sock" or fabric which traps and holds the DE during the filtration run. The picture at the right shows a set of septums for a round DE filter. The DE coats the outside of the septums and the water passes through it into the inside of the septum and then into the piping to go back to the pool. These filters will work using either pressure or vacuum. We probably see more vacuum DE filters than any other type of vacuum filter.

The flow rate for the DE filter is between about 1 – 2 gpm / sq. ft. While this is much slower than High rate sand, because of the septum design and spacing, filters of equivalent capacity take up fairly similar amounts of space.

To clean this filter, the water flow is reverses and the DE is released to go to waste, or the filter tank is drained and the septums are hosed off to remove the DE. The dirty DE is disposed of and new DE is used for the new filter cycle.

About once a year, the septums are cleaned with a good degreasing solution to remove any oil buildup and sometimes then acid washed to remove any mineral buildup. They are checked to make sure there are no broken septum supports or holes in the "socks"

Cartridge Filters

Cartridge Filters are pressure type filters that have a filter cartridge that fits inside the filter housing. This filter is removable for cleaning and is not cleaned in place, except that some very large cartridges may need to be hosed down in place to remove a portion of the dirt to allow them to be lifted out of the filter.

One of the main advantages of a cartridge filter is that the cleaning of the filter takes less water than what is normally used for sand or DE filter cleaning or backwashing. One disadvantage of the cartridges is that they are quite expensive and have to be replaced about every 2 – 5 years depending on the pool conditions.

The cartridges are usually a spun polyester fiber. The cartridges are constructed with an accordion pleat and look much like the air cleaner in your car. Because of the folding, a great deal of surface area can be packed into a fairly small amount of space.

The flow capacity of the cartridge filter for a cartridge filter with a capacity approximately that of sand fits inside the same size filter vessel. By slowing down the flow even further, the cartridge filter can reach an effectiveness approaching that of the DE filter for particle removal, and very long filter runs have been achieved between cleanings.

To clean a cartridge filter, the filter tank is disassembled and the cartridge removed. Typically a clean cartridge is kept to immediately replace the dirty cartridge and the filter is quickly back in operation.

The filter is hosed off to remove the dirt buildup. Sometimes a soft brush is used to help loosen the dirt. After the dirt is removed the cartridge should be soaked in a degreasing solution for several hours to overnight and then thoroughly rinsed. Occasionally this is followed by an acid wash in an acid solution. The filter is then thoroughly rinsed. Soaking in a disinfectant solution can remove the last dirt and grease and help disinfect the filter. Every filter should be allow to air dry until completely dry to make sure the filter is completely disinfected and ready to return to filtration duty.

ORP - Measuring Oxidation Reduction Potential

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Oregon Public Health Division
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INTRODUCTION

ORP stands for “Oxidation-Reduction Potential.” In some parts of the world, it is also known as “Redox Potential.” ORP measures the relative tendency of different substances to lose or gain electrons. In pools, it is a measurement showing a disinfectant’s potential to oxidize contaminants.

When chemists first used the term, the word "oxidation" meant "to combine with oxygen." We can see examples of oxidation all the time in our daily lives. Oxidation can occur at different speeds. When we see a piece of iron rusting, or a slice of apple turning brown, we are looking at examples of relatively slow oxidation. When we look at a fire, we are witnessing an example of rapid oxidation.

We now know that oxidation involves an exchange of electrons between two atoms. The atom that loses an electron in the process is said to be "oxidized." The one that gains an electron is said to be "reduced." The “reduced” atom no longer has an electrochemical potential, and the “oxidized” atom loses its attraction to the rest of its parent molecule. Chemicals like chlorine, bromine, and ozone are all oxidizers. It is their ability to oxidize - to "steal" electrons from other substances - that makes them good disinfectants, because in altering the chemical makeup of unwanted plants and animals, they kill them. Then they "burn up" the remains, leaving a few harmless chemicals as the by-product.

ORP is the only practical method we have to electronically monitor sanitizer effectiveness. The World Health Organization (WHO) has determined that an electrochemical potential (ORP) of 650 mV will disinfect drinking water. Because much of the “work” of the disinfectant is to oxidize materials as well, a minimum standard of 750 mV is used. This does not correlate to any particular part per million (ppm) measure, as there are many factors which effect the ORP reading.

ORP MEASUREMENT

Of all the factors involved in chemical maintenance; two, disinfectant residual and pH, are measured and adjusted most often. These are measured by a pool controller using the measurements from two different electrode probes inserted into the water stream.

When measuring ORP, an inert metal electrode is used to acquire the electrochemical potential of electrons. Platinum and gold are the most common ORP electrode materials. The actual potential is measured between the metal electrode and a reference electrode. This measurement is the actual ability of the water and its components to oxidize; like a battery charged with stored disinfection and oxidation energy. Newer probes, with more highly refined electrodes, have a better ability to measure small changes in the ORP. These newer electrodes are used for High Resolution Redox (HRR) controllers. ORP and HRR essentially measure the same thing.

The oxidation potential for a pool should be maintained at 750 mV or higher.

pH DEPENDENCE

Chlorine ORP measurement is very pH dependent. As the pH of the solution rises, the ORP potential will decline. As we know, chlorine forms variable amounts of Hypochlorous Acid (HOCl - the active disinfectant) and Hypochlorite ions (OCl^- - inactive chlorine) depending on the pH. ORP is measures only the active chlorine (HOCl), other oxidizing disinfectants are measured similarly.

ORP ELECTRODE CONTAMINATION AND CLEANING

Generally, an ORP electrode will rapidly measure the ORP of the water. The speed and accuracy is dependent on the condition of the electrode. The electrode will collect grease that can be cleaned off with a mild degreaser such as “Fantastick” (no spamming intended). Spray it on, wait and rinse. Occasionally the electrode can collect some calcium deposits which can be removed from a platinum electrode with a mild solution of hydrochloric (muriatic) acid. Always degrease before acid cleaning. Cleaning the metal electrode with an abrasive material is not recommended. After chemical cleaning, the ORP electrode may exhibit unstable readings until it has stabilized. This stablization may take overnight.

ORP ELECTRODE CALIBRATION

Since ORP is a characteristic measure of redox equilibrium, the ORP electrode should not require standardization or calibration. The measured potential is absolute. However, it is desirable to check instruments for proper operations and contamination.

Unfortunately, at this time, the pool rules do not recognize ORP or HRR. Because of this, you will have to monitor both the ORP values, and the disinfectant ppm residuals required in the code. It is fairly easy to use both by adjusting the pH up or down slightly until the ppm reading falls within the code requirements. Since ORP, read in millivolts (mV), is a better method of determining disinfectant effectiveness, the Health Division will try to accommodate, when possible, variations between the disinfectant levels in ppm and the ORP readings in mV.

02/07

Healthy Swimming

Fecal Incident Response Recommendations for Pool Staff*

What do you do when you find poop in the pool?

*Check for existing guidelines from your local or state regulatory agency before use.
CDC recommendations do not replace existing state or local regulations or guidelines.

- These recommendations are for responding to fecal incidents in chlorinated recreational water venues.
- Improper handling of chlorine-based disinfectants can cause injury. Follow proper occupational safety and health requirements when following these recommendations.
- **Pool Closures:** Fecal incidents are a concern and an inconvenience to both pool operators and patrons. Pool operators should carefully explain to patrons why the pool needs to be closed in response to a fecal incident. Understanding that pool closure is necessary for proper disinfection and protection of the health and safety of swimmers is likely to promote support rather than frustration. Pool closures allow chlorine to do its job — to kill germs and help prevent recreational water illnesses (RWIs).

Important background info...

WHAT ARE RECREATIONAL WATER ILLNESSES (RWIs)?

What is the first thing that pops into your head when you think about water safety? Drowning? Slipping? Lightning? All good answers, and all are very important. But, did you know that germs can contaminate swimming water? These germs cause RWIs that have made many people sick.

RWIs are caused by germs such as “Crypto” (KRIP-toe), short for *Cryptosporidium*, *Giardia* (gee-ARE-dee-uh), *E. coli* 0157:H7, and *Shigella* (Shi-GEL-uh).

HOW ARE RWIs SPREAD?

RWIs are spread by swallowing pool water that has been contaminated with fecal matter. How? If someone has diarrhea, that person can easily contaminate the pool. Think about it. Pool water is shared by every swimmer. Really, it’s communal bathing water. It’s not sterile. It’s not drinking water.

The good news is that germs causing RWIs are killed by chlorine. However, chlorine doesn’t work right away. It takes time to kill germs and some germs like Crypto can live in pools for days. Even the best maintained pools can spread illness.

SHOULD ALL FECAL INCIDENTS BE TREATED THE SAME?

No. A diarrheal fecal incident is a higher-risk event than a formed-stool incident. With most diarrheal illnesses, the number of infectious germs found in each bowel movement decreases as the diarrhea stops and the person’s bowel movements return to normal. Therefore, a formed stool is probably less of a risk than a diarrheal incident that you may not see.

A formed stool may contain no germs, a few, or many that can cause illness. You won’t know. The germs that may be present are less likely to be released into the pool because they are mostly contained within the stool. However, formed stool also protects germs inside from being exposed to the chlorine in the pool, so prompt removal is necessary.

Germ Inactivation Time for Chlorinated Water*

Germ	Time
E. coli O157:H7 Bacterium	Less than 1 minute
Hepatitis A Virus	About 16 minutes
Giardia Parasite	About 45 minutes
Crypto Parasite	About 15,300 minutes or 10.6 days†

SHOULD YOU TREAT A FORMED FECAL INCIDENT AS IF IT CONTAINS CRYPTO?

No. In 1999, pool staff volunteers from across the country collected almost 300 samples from fecal incidents that occurred at water parks and pools.¶ CDC then tested these samples for Crypto and *Giardia*. None of the sampled feces tested positive for Crypto, but *Giardia* was found in 4.4% of the samples collected. These results suggest that formed fecal incidents pose only a very small Crypto threat but should be treated as a risk for spreading other germs (such as *Giardia*). Remember a diarrheal fecal incident is considered to be a higher-risk event than a formed-stool fecal incident.

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* 1 parts per million (ppm) or mg/L free chlorine at pH 7.5 or less and a temperature of 77°F (25°C) or higher.

† Shields JM, Hill VR, Arrowood MJ, Beach MJ. Inactivation of *Cryptosporidium parvum* under chlorinated recreational water conditions. J Water Health 2008;6(4):513–20.

¶ CDC. Prevalence of Parasites in Fecal Material from Chlorinated Swimming Pools — United States, 1999. MMWR 2001;50(20):410–2.

What do I do about...

formed stool in the pool?

Formed stools can act as a container for germs. If the fecal matter is solid, removing the feces from the pool without breaking it apart will limit the degree of pool contamination. In addition, RWIs are more likely to be spread when someone who is ill with diarrhea has a fecal incident in the pool.

diarrhea in the pool?

Those who swim when ill with diarrhea place other swimmers at significant risk for getting sick. Diarrheal incidents are much more likely than formed stool to contain germs. Therefore, it is important that all pool managers stress to patrons that swimming when ill with diarrhea is an unhealthy swimming behavior.

1. **For both formed-stool and diarrheal fecal incidents,** close the pool to swimmers. If you have multiple pools that use the same filtration system — all pools will have to be closed to swimmers. Do not allow anyone to enter the pool(s) until the disinfection process is completed.
2. **For both formed-stool and diarrheal fecal incidents,** remove as much of the fecal material as possible (for example, using a net or bucket) and dispose of it in a sanitary manner. Clean and disinfect the item used to remove the fecal material (for example, after cleaning, leave the net or bucket immersed in the pool during disinfection).

VACUUMING STOOL FROM THE POOL IS NOT RECOMMENDED.

Formed stool:

3. Raise the free chlorine to 2 parts per million (ppm), if less than 2 ppm, and ensure pH 7.5 or less and a temperature of 77°F (25°C) or higher. This chlorine concentration was selected to keep the pool closure time to approximately 30 minutes. Other concentrations or closure times can be used as long as the contact time (CT) inactivation value* is achieved (see next page).
4. Maintain free chlorine concentration at 2 ppm and pH 7.5 or less for at least 25 minutes before reopening the pool. State or local regulators may require higher free chlorine levels in the presence of chlorine stabilizers,† which are known to slow disinfection. Ensure that the filtration system is operating while the pool reaches and maintains the proper free chlorine concentration during the disinfection process.

Diarrhea:

3. If necessary, before attempting the hyperchlorination of any pool, consult an aquatics professional to determine the feasibility, the most optimal and practical methods, and needed safety considerations.
4. Raise the free chlorine concentration to 20 ppm¶,§ and maintain pH 7.5 or less and a temperature at 77°F (25°C) or higher. The free chlorine and pH should remain at these levels for at least 12.75 hours to achieve the CT inactivation value of 15,300.** **Crypto CT inactivation values are based on killing 99.9% of Crypto. This level of Crypto inactivation cannot be reached in the presence of 50 ppm chlorine stabilizer, even after 24 hours at 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C).†† Extrapolation of these data suggest it would take approximately 30 hours to kill 99.9% of Crypto in the presence of 50 ppm or less cyanuric acid, 40 ppm free chlorine, pH 6.5, and a temperature of 77°F (25°C) or higher.**
5. Confirm that the filtration system is operating while the water reaches, and is maintained, at the proper chlorine level for disinfection.
6. Backwash the filter after reaching the CT inactivation value. Be sure the effluent is discharged directly to waste and in accordance with state or local regulations. Do not return the backwash through the filter. Where appropriate, replace the filter media.
7. Allow swimmers back into the water only after the required CT inactivation value has been achieved and the free chlorine and pH levels have been returned to the normal operating range allowed by the state or local regulatory authority.

Establish a fecal incident log. Document each fecal incident by recording date and time of the event, whether it involved formed stool or diarrhea, and the free chlorine and pH levels at the time or observation of the event. Before reopening the pool, record the free chlorine and pH levels, the procedures followed in response to the fecal incident (including the process used to increase chlorine levels if necessary), and the contact time.

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* CT inactivation value refers to concentration (C) of free chlorine in ppm (or mg/L) multiplied by time (T) in minutes at a specific pH and temperature.

† Chlorine stabilizers include compounds such as cyanuric acid, dichlor, and trichlor.

¶ Many conventional test kits cannot measure free chlorine levels this high. Use chlorine test strips that can measure free chlorine in a range that includes 20–40 ppm (such as those used in the food industry) or make dilutions with chlorine-free water when using a standard DPD test kit.

§ If pool operators want to use a different free chlorine concentration or inactivation time, they need to ensure that CT inactivation values always remain the same (see next page for examples of how to accomplish this).

** Shields JM, Hill VR, Arrowood MJ, Beach MJ. Inactivation of *Cryptosporidium parvum* under chlorinated recreational water conditions. J Water Health 2008;6(4):513–20.

†† Shields JM, Arrowood MJ, Hill VR, Beach MJ. The effect of cyanuric acid on the chlorine inactivation of *Cryptosporidium parvum*. J Water Health 2008; 7(1): 109–114.

Pool disinfection time...

How long does it take to disinfect the pool after a fecal incident? This depends on what type of fecal incident has occurred and at which free chlorine levels you choose to disinfect the pool. If the fecal incident is formed stool, follow Figure 1, which displays the specific time and free chlorine levels needed to inactivate *Giardia*. If the fecal incident is diarrhea, follow Figure 2, which displays the specific time and free chlorine levels needed to inactivate Crypto.

Figure 1 *Giardia* Inactivation Time for a Formed-Stool Fecal Incident

Free Chlorine Level (ppm)	Disinfection Time*
1.0	45 minutes
2.0	25 minutes
3.0	19 minutes

* These closure times are based on 99.9% inactivation of *Giardia* cysts by chlorine at pH 7.5 or less and a temperature of 77°F (25°C) or higher. The closure times were derived from the U.S. Environmental Protection Agency (EPA) Disinfection Profiling and Benchmarking Guidance Manual. These closure times do not take into account "dead spots" and other areas of poor pool water mixing.

Figure 2 Crypto Inactivation Time for a Diarrheal Fecal Incident

Free Chlorine Level (ppm)	Disinfection Time*†
10	1,530 minutes (25.5 hours)
20	765 minutes (12.75 hours)
40	383 minutes (6.5 hours)

* Shields JM, Hill VR, Arrowood MJ, Beach MJ. Inactivation of *Cryptosporidium parvum* under chlorinated recreational water conditions. J Water Health 2008;6(4):513–20.

† At pH 7.5 or less and a temperature of 77°F (25°C) or higher.

The **CT inactivation value** is the concentration (C) of free chlorine in ppm multiplied by time (T) in minutes (CT inactivation value = C x T). The CT inactivation value for *Giardia* is 45 and the CT inactivation value for Crypto is 15,300 (pH 7.5 or less and a temperature of 77°F [25°C] or higher). If you choose to use a different free chlorine concentration or inactivation time, you must ensure that the CT inactivation values remain the same.

For example, to determine the length of time needed to disinfect a pool after a diarrheal incident at 15 ppm, use the following formula: C x T = 15,300.

Solve for time: T = 15,300 ÷ 15 ppm = 1020 minutes or 17 hours. It would take 17 hours to inactivate Crypto at 15 ppm.

POOL

Public Swimming Pool Daily Record Sheet

DHS Oregon Department of Human Services

Month / Year	Name of Pool:	Location – City

Operator's Initials	DATE	*Daily Pre-Opening Tests*					Total Alkalinity (1x / week)	Calcium Hardness (1x / wk)	Cyanuric Acid (1 x month)	TDS (Monthly)	Free Cl / Br Readings (1 or 4 hrs)							Number of Bathers - Total	Backwashed – Clean Filters	Recirculation Rate - GPM	Comments – 8 Chemical Added / Amount 8 Pool Problems 8 Mechanical Breakdowns 8 Swimmer Emergencies > (File Accident Report)
		Clarity	Pool Temp	Free Chlorine/Bromine	Combined Cl	pH					Insert the Time the Test is Done (below)										
	1																				
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	3																				
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Comments: ______________________________________

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Swimming Pool Water Quality Parameters

	Min.	Ideal	Max.
Free Chlorine	**0.8 ppm**	**1.5-3.0 ppm**	**5.0 ppm**
Combined Chlorine	**0**	**0**	**0.5 ppm**
Bromine	**3.0 ppm**	**3.0-5.0 ppm**	**8.0 ppm**
pH	**7.2**	**7.3-7.5**	**7.6**
Total Alkalinity	**70 ppm**	**80-120 ppm**	**180 ppm**
Calcium Hardness	**175 ppm**	**250-350 ppm**	**-**
Cyanuric Acid	**0**	**0**	**150 ppm**

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POOL

Public Swimming Pool Safety Checklist

Month / Year		License Number
Name of Facility		
Street Address		
City, State Zip		
Name of Operator	Phone	

Monthly Safety Self-Inspection

] Item Checked — Maintenance Comments

Pool & Enclosure

- □ Fences – Openings < 4”, Good Repair
- □ Doors & Gates – Self-Closes, Completely Latches, Good Condition
- □ Window / Sliding Glass Door – Open < 4”
- □ Deck Equipment – Good Condition, Fasteners and Fittings not corroded Ladders – Handrail tight, Rungs tight Starting Blocks - Removed / Disabled Installed in >5’ water depth
- □ Deck – Clean, Disinfected, Good Repair, No Puddles, No Carpet/Matting/Wood
- □ Skimmers / Gutters / Tile Line – Clean, Good Repair
- □ Lighting – Maintained, Adequate
- □ Safety Equipment – Provided, Good Repair First Aid Kit Stocked, Phone Working Rescue Tubes Provided and Used
- □ Test Kit – Clean, Stocked w/ Fresh Reagents, Stored in Cool, Dry Location

Recirculation Equipment

- □ Pumps / Filter / Disinfectant Feeders Maintained, Good Repair
- □ Gauges – Working, Accurate Readings within Parameters
- □ Piping – Good Repair, Marked, No Leaks

Lifeguard Supervision

Use the space below to note any items of interest noted during routine lifeguard supervision. Items such as rescue tube use, scanning technique, alertness, use of sun protection, distractions, rescue incidents, people skills, etc. These notes can be used later for individual coaching or in-service training. Documentation can show behaviors noted and modified for liability and supervision purposes. More complete documentation should be included, as needed, in each employee’s personnel files.

Date	Comment	Date	Comment

SPA

Public Spa Pool
Daily Record Sheet

DHS Oregon Department of Human Services

Month / Year	Name of Pool:	Location – City

Operator's Initials	DATE	Daily Pre-Opening Tests					Total Alkalinity (2x / week)	Calcium Hardness (1x / wk)	Cyanuric Acid (1x / week)	TDS (Monthly)	Free Cl / Br Readings (1 or 2 hrs) Insert the Time the Test is Done (below)							Number of Bathers - Total	Backwashed – Clean Filters	Recirculation Rate - GPM	Comments – 6 Chemical Added / Amount 6 Spa Problems 6 Mechanical Breakdowns 6 Bather Emergencies > (File Accident Report)
		Clarity	SPA Temp (<104°F.)	Free Chlorine / Bromine	Combined Cl	pH															
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Comments: ___________________________________

Public Spa Pool - Water Quality Parameters

	Min.	Ideal	Max.
Free Chlorine	**1.5 ppm**	**3.0 – 5.0 ppm**	**5.0 ppm**
Combined Chlorine	**0**	**0**	**0.5 ppm**
Bromine	**3.0 ppm**	**3.0-5.0 ppm**	**8.0 ppm**
pH	**7.2**	**7.3-7.5**	**7.6**
Total Alkalinity	**70 ppm**	**80-120 ppm**	**180 ppm**
Calcium Hardness	**175 ppm**	**250-350 ppm**	**-**
Cyanuric Acid	**0**	**0**	**150 ppm**

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SPA

Public Spa Pool Safety Checklist

Month / Year		License Number
Name of Facility		
Street Address		
City, State Zip		
Name of Operator	Phone	

Monthly Safety Self-Inspection

] Item Checked

Maintenance Comments

Spa & Enclosure

- □ Fences – Openings < 4", Good Repair
- □ Doors & Gates – Self-Closes, Completely Latches, Good Condition
- □ Window / Sliding Glass Door – Open < 4"
- □ Deck Equipment – Good Condition, Fasteners and Fittings not corroded Stairs – Handrail tight
- □ Depth Marking – Easily Readable
- □ Deck – Clean, Disinfected, Good Repair, No Puddles, No Carpet/Matting/Wood
- □ Spa Basin – In Good Repair
- □ Skimmers / Gutters / Tile Line – Clean, Good Repair
- □ Lighting – Maintained, Adequate
- □ Safety Equipment – Provided, Good Repair First Aid Kit Stocked, Phone Working
- □ Test Kit – Clean, Stocked w/ Fresh Reagents, Stored in Cool, Dry Location
- □ Spa Temperature - <104^{o}F. (Ideal 102^{o}F. or less)
- □ Water Changed – at least monthly, best changed when ("# of bathers" = Volume (gal.) / 3)

Recirculation Equipment

- □ Pumps / Filter / Disinfectant Feeders Maintained, Good Repair
- □ Gauges – Working, Accurate Readings within Parameters
- □ Piping – Good Repair, Marked, No Leaks

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Public Swimming Pool Accident / Drowning Report

State of Oregon
Department of Human Services
Public Health Services

Environmental Services and Consultation
800 NE Oregon Street # 21
Portland, Oregon 97232-2162
Phone (971) 673-0451 FAX (971) 673-0457

This report must be completed for every physician-treated accident or any drowning at a public swimming pool. It is the **responsibility of the pool operator** to submit the completed form promptly to the **Oregon Department of Human Services, Environmental Services and**

Date of Incident	Time:	am pm

Accident ID #	YYYY – MMDD - County #
Official Use Only	

Victim Information

First Name	**MI**	**Last Name**
Address Number	**Street**	**Apt.#**
City or Town	**State**	**Zip Code**

SEX: ❑ M ❑ F	**Age of Victim:**(yrs)	❑ **Fatal** ❑ **Non-Fatal**	**Non-Swimmer:** ❑ Yes ❑ No ❑ Unk

Area of the Body Injured: (Check all that Apply)

- ❑ Head
- ❑ Trunk
- ❑ Arm / Hand / Finger
- ❑ Leg / Foot / Toe
- ❑ Other (Specify)

Type of Injury: (Check all that Apply)

- ❑ Abrasion or Contusion
- ❑ Strain or Sprain
- ❑ Concussion
- ❑ Fracture
- ❑ Laceration
- ❑ Other (Specify)

Treatment Required: (Check all that Apply)

- ❑ No Treatment
- ❑ First Aid
- ❑ CPR (❑ Manual ❑ AED ❑ Oxygen)
- ❑ Doctor's Office/Emergency Room
- ❑ Admitted to Hospital
- ❑ Other (Specify)

Pool Information

Pool License #

Name of Pool		
Address Number	**Street**	
City	**State**	**Zip Code**
Contact Person	**Position**	**Phone**

Was the pool open at the time?	Was a lifeguard on duty at the time?
❑ Yes ❑ No	❑ Yes ❑ No

Factors contributing to the accident (Mark as many as apply)

Slippery Surfaces:	❑ Around Pool ❑ Bottom of Pool ❑ Other (Specify)
Deck Equipment:	❑ Ladder / Handrails ❑ Lifeguard Equipment ❑ Other (Specify)
Recirculation Equipment:	❑ Mechanical ❑ Electrical ❑ Other (Specify)
Use of Pool Chemicals:	❑ Storage ❑ Handling ❑ Other (Specify)
Pool Enclosure:	❑ Inadequate ❑ Gate - Unlatched or Unlocked ❑ Other (Specify)
Diving/Jumping/Sliding:	❑ From Board ❑ From Poolside ❑ From Slide ❑ Other Specify
Horseplay/ Miscalculation:	(Specify)
Other: (Explain)	❑ Involved Food/Drink ❑ Natural Causes
Were Others Injured:	❑ Yes ❑ No
If Yes, Name(s)	

Describe what happened: (Please be legible)

Print or Type Name:	Signature:	Date:

PHS 100 (Draft Revision 7/2005)