Nebraska Swimming Pool Operators Class

Presented by
Lincoln Lancaster County Health Department

NEBRASKA
DEPT. OF ENVIRONMENT AND ENERGY

Lincoln-Lancaster County Health Department

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Class Outline

- Healthy Swimming
- Rules and Regulations
- Circulation and Filtration
- Water Balance
- Water Treatment
- Water Testing Methods
- Spas

Photo: Clip Art

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Healthy Swimming

Photo: Clip Art

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Chlorine Enemies

- Environmental
  - Street and workplace dust, pollen, air pollutants, animal droppings
  - Insects, grass, leaves
  - Sun/heat
    - For every 10 F above 80 F, twice as much chlorine is needed to maintain adequate free chlorine level (Sciencing.com, Scientific American)

Photo: LLCHD

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Chlorine Enemies

- Public Bathers
  - Fecal residue
  - Body grime and dead skin
  - Body discharges
    - Mucous, saliva, sweat, urine
  - Body lotions and creams
  - Personal care products

Photo: CDC

- Shower WITH SOAP before entering pool!!!!!!

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Screen Bathers

- Watch bathers for:
  - Sore or inflamed eyes
  - Colds
  - Nasal or ear discharge
  - Wounds, boils, or other obvious skin or body infections

Photo: CDC

EXCLUDE THEM FROM THE POOL!

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Healthy Swimming

Waterborne germs can cause:

- Eye infection
  - Conjunctivitis (pinkeye)
- Ear infection
- Skin infection
- Respiratory infection
- Gastrointestinal

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Pool Germs

- Cause serious illness in healthy people
- Life threatening for high risk population
  - Elderly
  - People in poor health
  - Pregnant women
  - Young children



Photo: CDC

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Potential Pool Germs

- *Cryptosporidium*
- *Shigella*
- *E. coli*
- *Legionella*

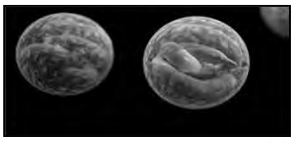
Image: CDC

- MRSA - Methicillin Resistant Staphylococcus Aureus

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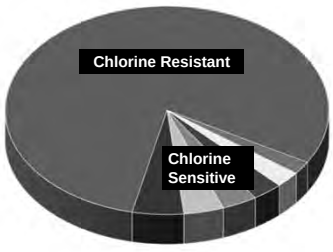
Waterborne Disease Outbreaks

United States, 2003-2012



Credit: CDC

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Germ Inactivation Time

1 ppm chlorine at 7.5 pH

E. coli, bacteria ---→ Less than 1 minute

Hepatitis A, virus ---→ About 16 minutes

Cryptosporidium, parasite

⇩

15,300 minutes or 10.6 days

"Fecal Incident Response Recommendations for Pool Staff" www.cdc.gov/healthyswimming (2016)

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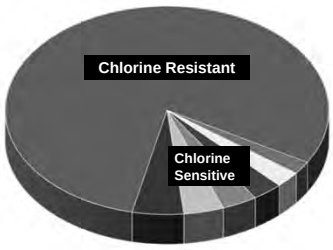
Adding it all Up

Chlorine resistant germs



Credit: CDC

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Adding it all Up

Chlorine resistant germs

+

Poor pool maintenance

Photo: LLCHD

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Adding it all Up

Chlorine resistant germs

+

Poor pool maintenance

+

Young children with diarrhea

Photo: CDC

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Adding it all Up

Chlorine resistant germs

+

Poor pool maintenance

+

Young children with diarrhea

Source: Tulsaworld.com

+

Bathers swallowing pool water

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Adding it all Up

Chlorine resistant germs

+

Poor pool maintenance

+

Young children with diarrhea

+

Bathers swallowing pool water

Photo: CDC

= Increased Risk of Outbreaks

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Adding it all Up

- Eliminate/Reduce Risk-

  Don't Drink the Pool Water!

  That is how Crypto is spread!

Liveabout.com

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Infectious Doses

- Infectious Doses

	Healthy Adult	Toddler
▪ *Salmonella*	1000	100
▪ *Shigella* and *E. coli*	100	10
▪ *Cryptosporidium*	10	1

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Healthy Swimming

One diarrhea accident can release large amounts of contaminated material into a pool or spa…

AND MILLIONS OF DANGEROUS GERMS!

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Cryptosporidiosis Outbreaks

2009-2017

The number of outbreaks reached:

444 (CDC's Morbidity and Mortality Report)

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Fecal Accident

- Every pool or spa needs an established procedure when fecal accidents occur.
- CDC Guidelines


Photo: CDC

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Fecal Accident

Should you treat a formed fecal accident as if it contains *Cryptosporidium*?

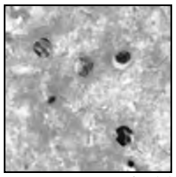
Photo: CDC

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Fecal Accident

- Volunteers collected 300 samples from fecal accidents involving formed stools at water parks and pools.
- None tested positive for Crypto

"Fecal Incident Response Recommendations for Pool Staff" www.cdc.gov/healthyswimming (August 1, 2008)

*Remember…a diarrheal fecal accident is a higher risk than a formed stool.

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Fecal Accident

- Fecal accident response*- Formed Stool
  - Direct everyone to leave the pool
  - Remove as much fecal material as possible
  - Ensure chlorine is at least 2 ppm and pH 7.5 or less
  - Maintain chlorine and pH at those levels for at least 25 minutes

*CDC recommendations found at www.cdc.gov/healthyswimming

Report any fecal incidents to the your local health department

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Fecal Accident
Non-stabilized Pool (No Cyanuric Acid)

- Fecal accident response - Diarrheal Stool*
  - Direct everyone to leave the pool. Close pool.
  - Remove as much fecal material as possible
  - Raise chlorine to 20 ppm and maintain pH 7.5 or less
  - Maintain chlorine and pH at those levels for 13 hours**
  - Backwash filter
  - Return chlorine to normal operating range
  - Bromine pools must increase the chlorine level to 20ppm. This is because bromine does not kill cryptosporidium.

*CDC recommendations found at www.cdc.gov/healthyswimming
** Or any combination of chlorine level and time to meet a CT of 15,300
CT = Concentration x time

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Fecal Accident
Stabilized Pool (Cyanuric Acid)

- Fecal accident response-Diarrheal Stool*
  - Direct everyone to leave the pool. Close pool.
  - Remove as much fecal material as possible
  - Lower cyanuric acid to 1-15 ppm (draining)
  - Maintain a pH of 7.5 or less
  - 3 Options for Chlorine
    - Raise free chlorine to 20 ppm and maintain it for 28 hours
    - Raise free chlorine to 30 ppm and maintain it for 18 hours
    - Raise free chlorine to 40 ppm and maintain it for 8.5 hours
  - Backwash filter
  - Return chlorine to normal operating range

*CDC recommendations found at www.cdc.gov/healthyswimming

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Vomit Incident

How should you treat a vomit situation?

Same as a Formed Stool

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Vomit Incident

- Vomit accident response*
  - Direct everyone to leave the pool
  - Remove as much material as possible
  - Ensure chlorine is at least 2 ppm and pH 7.5 or less
  - Maintain chlorine and pH at those levels for at least 25 minutes
  - Same as a formed stool

*CDC recommendations found at www.cdc.gov/healthyswimming

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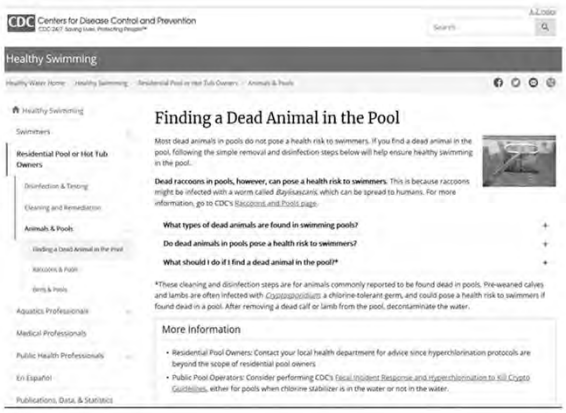

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Questions?

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Rules and Regulations

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Rules and Regulations

Title 178 Chapter 2

Updated

7/27/2020

Lincoln Operational and Management Standards for Public Swimming Pools

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Rules and Regulations

- The purpose of these rules and regulations is the prevention & reduction of:
  - Drowning and near drownings
  - Disease transmission
  - Injuries

Photo: CDC

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Pool Permits

- No public pool shall operate without a permit from NDEE (local permits may also be required)

Photo: LLCHD

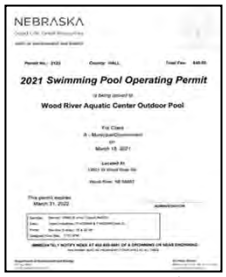

Photo: NDEE

- Permits are valid for one year

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Pool Construction

- Plans and specifications for new or reconstructed pools
  - Must be prepared by a licensed engineer or architect
  - Submitted to NDEE prior to construction
  - Additional $1000 for as-built plans
  - In-kind replacement does not apply to diving boards installed before June, 2004

Photo: Clip Art

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Classes of Pools

- Class A: Are pools operated by political subdivisions, governmental agencies, municipalities, and any other pool operated for the purpose of public swimming
- Class B: Are pools operated by hotels, motels, apartments, country clubs
- Class C: Spa pools
- Class D: Wading pools (stand alone)
- Class E: Spray parks
- Class F: Health clubs, fitness centers, community fitness centers

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Wading Pools & Spray Parks

- Wading Pools/Spray Parks
  - Have same chemical requirements (pH, chlorine, etc.) as adult pools
  - Require as much or more attention as adult pools
  - Wading Pools cannot be more than 24 inches deep
  - Spray Park cannot have any standing water

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Rules and Regulations

- Operator Responsibilities
  - Code compliance (must follow the rules!)
  - Pool & patron safety
  - Supervising users
  - Correctly operating recirculation system
  - Testing pool water (verifying water quality)

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Pool Operator

- Class A Pools
  - Direct and immediate supervision of a Nebraska swimming pool operator*
- Class B and F Pools
  - Must have a Nebraska swimming pool operator available** (within 60 mins.)

*Omaha/Douglas County requires all pools to be under immediate supervision

**Lincoln/Lancaster County requires Class B,C,D,E & F

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Drowning & Near Drowning

Notify Department Immediately (day or night) in the event of a:

- **Drowning**
- **Near-drowning**
- **Any death in the pool**

Photo: CDC

Emergency Contact Numbers all hours:

- NDEE – 402/525-6601
- Douglas County – 402/444-7000
- Lancaster County – 402/441-8000

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Accidents

Notify the Department within 24 hours for:

- Accident requiring hospitalization or medical treatment
- Fill out the accident report - http://dee.ne.gov/publica.nsf/pages/WAT297
- **New Fax Number: 402-471-2909**

Emergency Contact Numbers all hours:

- NDEE – 402/525-6601

  Douglas County – 402/444-7000
- Lancaster County – 402/441-8000

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Injury & Lawsuits

- Facilities in poor repair may results in slips and falls which can often cause injury and subsequent lawsuits!!!!!!

Photo: Clip Art

Photo: Clip Art

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Class A Facilities

Must conduct and document drills in handling emergencies

- Within 30 days of season opening
- Within 30 days with new employees
- Pools operating year round or more than 6 months per year must conduct emergency drills at least once every 6 months

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Lifeguard Qualifications

- Lifeguard qualifications
  - Completed nationally recognized course for lifeguards
  - CPR certification – renewed annually
  - Must be able to provide cards upon request

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Lifeguard Requirements

- Pool lifeguard requirements
  - # required is determined by the # of swimmers and/or by surface area
    - Minimum of one lifeguard per 100 bathers or 2,000 square feet of water surface area, whichever is the lesser number
    - Class B and F pools that choose to provide lifeguards must follow all lifeguard requirements of a class A pool

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Lifeguard Requirements

- Pool lifeguard requirements
  - Sufficient lifeguards on duty to allow for periodic rest breaks
  - Lifeguards must be in a position to view all areas responsibility
    - including the wading pool

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Lifeguard Requirements

Lifeguards

- Distinguishing swimsuits or emblem must be worn
- Rescue Tube
  - Within arm's reach
  - 6' long strap/tow rope
  - GOOD REPAIR!!!

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Lifeguard Requirements

Lifeguards

- Water slide requirements
  - 3 slides max
  - Within 50 feet of discharge
  - Guard only the slide area
- One lifeguard chair must be provided for each 2,000 square feet of water surface area unless area is under 2,000 square feet and be properly located

lincoln.ne.gov

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Lifeguard Requirements

Lifeguards are not required for

- Swim meets
- Swim classes

Photo: Clip Art

Photo: Clip Art

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Pool Operator CPR?

Boy Recovering After Nearly Drowning in Motel Pool

"A 7-year-old boy is recovering after nearly drowning in an Alliance motel pool. He was not breathing at the time, but an adult administered CPR and had the boy breathing again by the time rescue workers arrived. Authorities say the adult who administered CPR had been certified in the rescue technique only weeks earlier."

- April 29, 2008 Lincoln Journal Star –

- **Pool Operators are not required to hold CPR certification but it is a good idea**

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Rescue Equipment

Rescue Equipment**

Class A Pools

- Backboard with three straps
- Rescue Tube

Photo: LLCHD

Class B & F Pools

- Rescue Tube or Ring Buoy
  - Equipped with a rope as long as the width of the pool
- Shepherd's Crook
  - At least 12 feet long

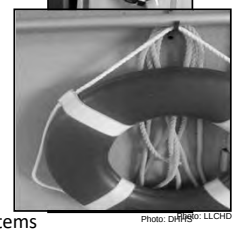

Photo: LLCHD

Must be conspicuous & accessible

** Immediate Closure Items

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First Aid Kit

- First aid kit:
  - Class A - Must have regulation listed items (Title 178 NAC 2, pg 29)
  - Classes B - F: First Aid Kit

Photo: LLCHD

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Class A Bathhouse

- A bathhouse is required for Class A pools
  - Disinfected daily
  - Checked periodically
  - Liquid soap (not bar soap) and paper towels provided
  - Hot water between 90º F and 115º F
  - 90º F to 105º F - single temp showers

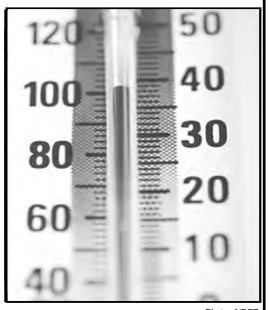

Photo: NDEE

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Emergency Telephone

- An emergency telephone must be available**
  - Post emergency number
  - Include name and address of facility
  - Check with your individual inspector on what they deem as available

If a cellular phone is used, service must be reliable, the phone charged at all times, and be equipped with 911 locations services

** Immediate Closure Item

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CO Detector

- CO detector required:
  - If gas heater is used
  - In pool area (indoor pool/spa)
  - In mechanical room (all pools/spas)

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GFCI

- Ground fault circuit interrupters – GFCI
  - Check all electrical at least once a year
    - Raleigh, N.C. - 17year old lifeguard lost her life in 2016 after she was electrocuted. Electric company failed to replace faulty wiring (Newsobserver.com)

Photo: LLCHD

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Sanitizer Requirements

- Sanitizer Pools/Wading Pools/Spray Parks**
  - 2-10 ppm free chlorine
  - 2-18 ppm bromine
- Sanitizer Spas**
  - 3-10 ppm free chlorine
  - 4-18 ppm bromine

Photo: LLCHD

** IMMEDIATE Closure Items

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Chemical Requirements

- pH shall be maintained between 7.2 to 7.8**
- Combined chlorine shall not exceed 0.5 ppm**
- Cyanuric acid exceeding maximum ppm**
  - 50 ppm in Lancaster County and Douglas County
  - 90 ppm in the rest of Nebraska

** IMMEDIATE Closure Items

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Other Chemical Requirements

- Total Alkalinity: Shall be no less than 80 ppm
- Calcium Hardness: No regulations
- ORP (oxidation – reduction potential): No regulations
  - Measure of the effectiveness of chlorine
  - Is not a measure of how much chlorine is in the pool

Photo: LLCHD

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Testing Requirements

- Test sanitizer and pH:
  - Prior to opening
  - Every 4 hours until closing
- Weekly tests
  - Combined chlorine
  - Total alkalinity
  - Cyanuric Acid (if used)
- Recorded on a log sheet


Photo: LLCHD

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Pool Log

Pool log is a 1 year* record of:

- Test results
- Chemistry adjustments
- Equipment maintenance
- Daily patron loads

Keep current copy of Pool Operator Card and Water Tester** Certificate on site!

*Douglas County requires keeping records 3 years

**Required in Lancaster County Only

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Main Drain Visibility

- The water must be free of floating and suspended materials
- The water must be clear enough to easily see the drain cover**


Photo: NDEE

** Immediate Closure Item

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Safety & Boundary Line

The boundary between the deep and shallow (5 ft.) must be clearly marked:

- Line 4 inches wide on floor and walls
- Safety rope
  - Rope may be removed during lessons, swim meets, and lap swim if group is supervised


Photo: NDEE

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Fencing

- The swimming pool shall be completely enclosed:
  - Fence 6 feet in height
  - No gaps greater than 4 inches

  <u>Self-closing and self latching gate or door</u>**
  - Or entrance is monitored

  ** Immediate Closure Item

Photo: NDEE

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Pool Tub

- Maintain the pool tub
  - Smooth tub surfaces
  - Cracks caulked
  - The bottom and sides of a pool must be white or a light color

Photo: NDEE

Photo: LLCHD

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Handrails & Ladders

- Handrails must be secure – needs a tool for removal
- Ladders equipped with slip resistant treads

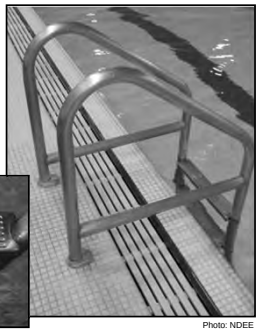

Photo: NDEE

Photo: NDEE

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Depth Markers

- Depth markers on tub walls and deck required every 25 feet
- Pools/spas with gutter systems may locate depth markers on interior walls or fence

  4 inch numbers

Photo: NDEE

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Pool Deck

- The pool deck must be in good repair with no
  - Cracks over ¼-inch
  - Tripping hazards over ½-inch
  - Low spots with standing water
- Decks free of bags to allow room for emergency personnel to reach victim

LLCHD

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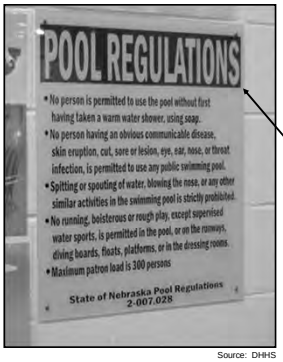
Signage



Source: DHHS

- Signage – Pools
- Post rules and regulations
  - Post pool capacity
  - Title 178 NAC 2, pg. 35
  - 4 inch lettering

Source: DHHS

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Signage

- "Authorized Personnel Only" on chemical storage rooms
- Storage rooms locked at all times

Source: DHHS

Source: DHHS

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Safety Data Sheet

Material safety data sheets (SDS) for the chemicals used at the pool must be at the facility in a location known and readily accessible to the facility staff

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Signage

- Signage
  - All pools, except Class A
    - Post "Warning - No Lifeguard on Duty" sign – 4 inch letters
    - Only if lifeguards are not provided

*Children under the age of 16 must not use pool without an adult in attendance – 2 inch lettering

Photo: NDEE

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Food and Drink

- No food or drink permitted in the pool
  - Water is allowed in unbreakable containers

- Food & drink allowed in unbreakable containers in designated areas only

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ADA REQUIREMENTS

- ADA requires that facilities be readily accessible to, and usable by, individuals with disabilities

http://www.ada.gov/pools_2010.htm

(800) 872-2253 ADA technical help line


Photo: LLCHD

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Pool Changes

- Plans and specs MUST be submitted* PRIOR to substantial modifications or improvements to the pool.
  - Stairs, Chlorinator Changes, Diving Boards
- NO plans and specs required for
  - A lift, temporary stairs or ramps
  - Maintenance or repairs

* - Plans and specs for pools/spa
  - Must be submitted by Nebraska engineer or architect
  - ALL pools are required to submit to NDEE

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Rules and Regulations

Reasons for closing a pool/spa

1. Sanitizer is out of the legal limit
2. Combined chlorine exceeds 0.5 ppm
3. pH is not between 7.2-7.8
4. Cyanuric acid exceeds maximum ppm
5. Pool drain cover is not clearly visible or is broken
6. Safety equipment is not available
7. Gates or doors are not self closing and self latching

Photo: LLCHD

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Rules and Regulations

Reasons for closing a pool/spa

8. Sufficient lifeguards are not present
9. Pool operator is not present or available
10. Weather conditions are threatening - lightning, hail
11. A fecal accident has occurred
12. Excessive dirt, floating matter or objects in pool. Loose pool lights, faulty wiring
13. Approved emergency telephone is not working

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Local Regulations

- Your local health department might have more stringent rules and regulations
- Always read both state and your local regulations to make sure you are in compliance
  - Lancaster County: LMC 8.38
  - Douglas County: Chapter 54 Articles I & II

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Questions??

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Circulation and Filtration

Photo: LLCHD

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Circulation and Filtration

Circulation: A closed system in which the water is

- Removed
- Filtered
- Sanitized
- Heated
- Returned

Filtration

- The physical removal of particles through a filtration media

Photo: LLCHD

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Circulation

Circulation requirements:

- Operate 24 hours a day
  - Effective sanitizer dilution
  - Proper sanitizer distribution

Photo: LLCHD

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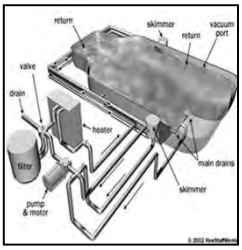
Circulation

- Circulation is influenced by
  - Inlet placement and design
  - Circulation pumps
  - Pool shape and contour
  - Piping and fittings
  - Surface and main drain water removal
  - Other systems such as heaters
  - Sanitizers



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Gutters

- Gutter systems
  - Maintain water level for removal of floating debris and for continuous overflow of water
  - Maintain grates, remove and clean

Photo: LLCHD

Photo: NDEE

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Skimmers

- Skimmers
  - Point source removal
  - Removable basket to trap large solids
  - Maintain the water level

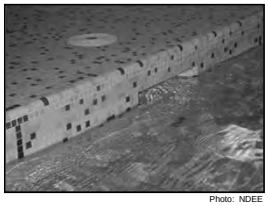

Photo: NDEE

Photo: LLCHD

THEY ARE NOT CHLORINATORS!!

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Filtration Room

- Filtration room
  - Inlet Pipes
  - Hair/Lint Strainer
  - Pump/Impeller
  - Motor
  - Filters
  - Heater
  - Chemical Feeders (always last!)
  - Return Pipes

Photo: NDEE

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Return Lines

- Return lines can be adjusted as needed
- Modified by changing orifices
- Point towards bottom and corners

Photo: NDEE

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Flow Gauge

- Flow gauge (Required)
  - Measures the flow of water in gallons per minute (gpm)
  - Determines turnover rate
  - 10-15% inaccuracy
  - Must be working
  - Check daily and write it down

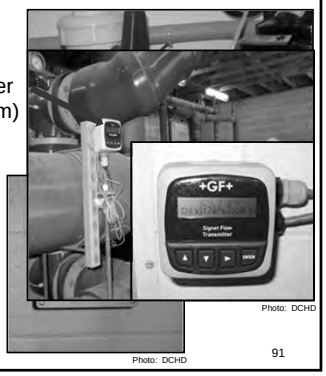

Photo: DCHD

Photo: DCHD

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Flow Rate

- If the flow rate changes
  - Check the skimmer basket
  - Check the filter gauges
  - Check the filter media
  - Check for obstructions in the piping or equipment
  - Check the pump impeller


Photo: LLCHD


Photo: LLCHD

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Turnover Rate

- Turnover rate
  - Time for entire volume of water to be filtered
  - Based on pool volume (Length x Width x avg Depth x 7.5=volume)
  - Turnover rate equals:
  - Volume of the pool divided by flow rate divided by 60
    - Example: 60,000 ÷ 300 gpm ÷ 60 = 3 hrs 20 min.

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Turnover Rate

- If the turnover rate of a pool is too long, pollutant levels will start to build up.
- If the turnover time is too short, the water will be traveling too fast through the system and this will have a negative impact on the effectiveness of the filtration.
- Knowing the flow rate and turnover rate and checking them is vitally important to proper pool maintenance.
(Stockwell Safety)

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Turnover Rates

- Spray parks with no standing water and spas
  - 30 minutes or less
- Pool areas ≤ to 2 feet in water depth (wading pools)
  - One pool volume of water every 1 hour or less
- Pool areas greater than 2 feet but ≤ 3 feet in water depth
  - 2 hours or less
- Pool areas greater than 3 feet but ≤5 feet in water depth
  - 4 hours or less
- Pool areas greater than 5 feet in water depth
  - 6 hours or less

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Filters

- Filter effectiveness
  - Type of filter
  - Surface area
  - Velocity of water
  - Condition of the media
  - Particulates in the water

96

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Pressurized Filtration

- Filtration systems (two types)
  - Pressurized
    - The pump located ahead of filter
    - Closed tank
    - Cleaning based on pressures involved
      - Watch pressure gauges
      - Reverse flow (backwash) to clean
      - Sight glass runs clear
      - Recoat Elements (If DE used)

Photo: LLCHD/NDEE

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Suction Filtration

- Filtration systems (two types)
  - Suction (vacuum)
    - The pump located behind filter
    - Open system
    - Cleaning – physically removing the filter powder
      - Watch pressure gauges
      - Inspect condition of cloth elements

Source: Curtis Clark at www.wikimedia.com

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Types of Filters

- Media Materials
  - Sand
    - Gravity Sand
    - Rapid Sand
    - High Rate Sand
  - Diatomaceous Earth
  - Cartridge

Photo: NDEE

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Filter Gauges
Must be operational!

Photo: LLCHD

Photo: DCHD

Photo: DCHD

100

100

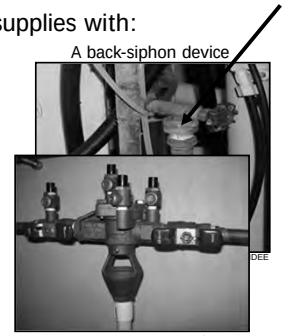
Cross Connection

- Protect all potable water supplies with:

An Air Gap

Photo: NDEE

A back-siphon device



DEE

Photo: LLCHD

Backflow Prevention Device

101

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VGB Act-2007
(Virginia Graeme Baker)

Graeme Baker - a 7 year old girl who died from suction entrapment due to a faulty drain cover

- **Entrapment**
  - Hair
  - Jewelry
  - Limb
  - Whole body

Photo: Pool Safety Council

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VGB Act Standards
(Virginia Graeme Baker)

- Drain covers MUST be secure & not cracked
- CHECK DRAIN COVER REPLACEMENT DATES!!!
  - Replace if needed

Photo: LLCHD

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Questions???

Refer to equipment manual

Contact equipment manufacturer

Contact pool service provider

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Water Balance

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Water Balance

Chemistry of water

- Water is the universal solvent
  - Balanced
  - Corrosive
  - Scale forming

Source: Clip Art

106

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Water Balance

- Proper water balance will
  - Optimize the sanitizer (chlorine/bromine)
  - Extend the life of the pool equipment and pool deck
  - Provide for bather comfort
  - Improve filter runs
  - Maintain clear water

Source: Clip Art

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Water Balance

- Balanced water is the correct ratio of
  - pH
  - Total alkalinity
  - Calcium hardness
  - Temperature
- All are dependent on each other
- Also called the saturation index

Source: LLCHD

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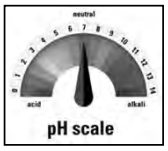
pH (potential of Hydrogen)

- pH Has the greatest affect on the pool/spa water
  - Measures how acidic or basic a solution is
  - Pool chemistry 7.2-7.8



Source: USGS

109

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pH

- What affects pH
  - **Chemicals used**
  - Swimmer's pH 4.5-6.0
  - Weather and environment
  - Water source
  - Algae

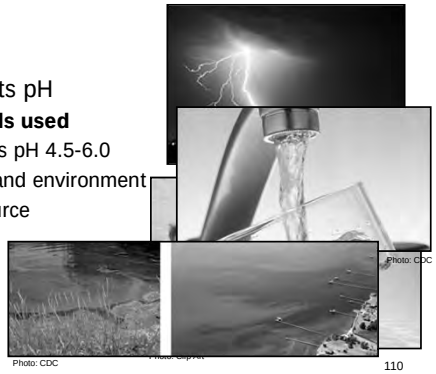

Photo: CDC

Photo: CDC

110

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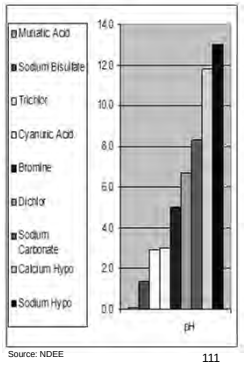
pH Values

- pH values of chemicals used

Muriatic acid	0.1
Sodium bisulfate	1.4
Trichlor	***2.9***
Cyanuric acid	3.0
Bromine	***5.0***
Dichlor	***6.7***
Sodium carbonate	8.3
Calcium hypo	***11.8***
Sodium hypo	***13.0***



Source: NDEE

111

111

Chlorine & pH

Two products are formed when water and chlorine are mixed

- Hypochlorous acid - effective sanitizer
- Hypochlorite - less effective sanitizer

The amount of hypochlorous acid and hypochlorite produced is:

pH dependent

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Chlorine & pH

pH		Hypochlorous Acid
7.2	⇨	66%
7.5	⇨	50%
7.8	⇨	33%
8.0 +	⇨	0%

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High pH

- High pH (7.9 or higher)
  - Scale formation
  - Water becomes cloudy
  - Filters runs are shorter
  - Chlorine is ineffective
    - Increased risk of disease

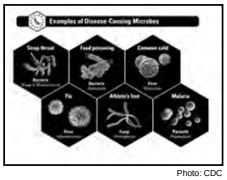

Photo: CDC

114

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Low pH

- Low pH (7.1 or lower)
  - Water becomes acidic
  - Chlorine dissipates rapidly
  - Eye irritation occurs
  - Plaster walls are etched
  - Metal corrodes
  - Dissolved metals leave stains
  - Rapid loss of alkalinity

Photo: LLCHD

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pH Adjustments

- Raise pH
  - Sodium carbonate (soda ash)*
- Lower pH
  - Muriatic acid
  - Sodium bisulfate (dry acid)
- Follow label directions and adjust in small doses

Photo: NDEE

*Adding too much too fast causes milky white water

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Total Alkalinity

Total Alkalinity: A measure of the water's ability to fight pH change

- High alkalinity
  - pH lock
  - Cloudy water
  - Scale
- Low alkalinity
  - Unstable
  - Corrosive
  - pH bounce

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Total Alkalinity

Total Alkalinity

- Maintain at 80 ppm or higher for a stable pH
- Test Weekly

Photo: Clip Art

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Total Alkalinity Adjustments

- Total alkalinity
  - To raise total alkalinity
    - Add sodium bicarbonate
      - Baking soda
  - To lower total alkalinity
    - Add an acid
      - Muriatic Acid
      - Sodium Bisulfate

Photo: LLCHD

Add slowly and make adjustments in small doses
(ALWAYS! Follow manufacturer's recommendations)

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Temperature

- Temperature
  - Affects how chemicals dissolve
  - Most chemicals dissolve better as temperatures increase
  - Hardness (calcium carbonate) reacts the opposite

Photo: NDEE

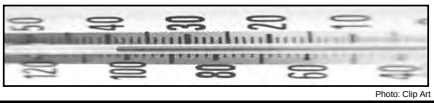

Photo: Clip Art

120

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Temperature

- Water temperature
  - Ideal range for pools
    - 80º F – Competition Swimming
    - 78º F to 82º F – Recreation

Photo: LPR

121

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Chemical Adjustment

- To make chemical adjustment
  - You need to know
    - How much of a change is needed
    - Proper chemical to make change
    - Pool volume
- Sequence for testing/adjustment
  - Total alkalinity-adjust to ≥80 ppm
  - pH – adjust to 7.2-7.8
  - Sanitizer – adjust to proper level

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Chemical Adjustment

When adding large amounts of chemicals to make a chemical adjustment:

- If possible, do so in smaller doses, over several days
- NEVER add chemicals when pool is occupied ***(follow manufacturer's guidelines)***

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Chemical Mixing

- Never mix stabilized and non-stabilized chlorine
  - If water contacts the mixture it can explode
- Always add chemicals to water, not water to chemicals
- http://www.achd.net/housing/PoolSafety.html

Photo: LLCHD

Photo: LLCHD

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Questions????

Photo: LLCHD

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Water Treatment

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Oxidation & Sanitization

- Sanitization
  - destroying pathogenic organisms (bacteria, fungi, protozoa, viruses...) harmful to human health in order to control communicable disease
- Oxidation
  - chemically removing organic debris (perspiration, saliva, urine, body oils & wastes, particulate matter…) from the water

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Oxidation

- Oxidation
  - The chemical cleaning of the pool or spa water
  - Converts sweat, debris, urine, & other organics into gases
  - Non-chlorine treatment for oxidation available
  - The terms shock, oxidation, and super chlorination are used interchangeably

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Chlorine Terms

- Free Chlorine: Good chlorine that will go out and kill germs
- Combined Chlorine: Bad chlorine that will cause eye irritation
- Total Chlorine: Free + Combined Chlorine

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Disinfectant Feeders

- Dichlor Feeder
  - Granular
- Liquid Feeders
  - Sodium Hypochlorite
  - Not very stable – loses strength
  - Very high pH (13) – acid feeders included
- Salt System
- Erosion Feeder
  - Trichlor/Bromine/Calcium Hypochlorite
  - Slow dissolving
  - Operation affected by: Solubility (low),Water temperature, Flow rate, Amount of product in feeder

Photo: NDEE

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Sanitizers

Sanitizers facilitate oxidation of pool water

- Every pool must have a working disinfection system!
- Primary Sanitizers
  - Chlorine
    - Granular, Tablet & Liquid
  - Bromine
    - Tablet

Photo: LLCHD

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Secondary Oxidizers

Other sanitizers facilitate oxidation of pool water

- Secondary Oxidizers
  - Ozone
  - Ultraviolet Light

Still must have a chlorine or bromine residual!!

Photo: LLCHD

Photo: DHHS

132

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Combined Chlorine

- Chlorine is the most common sanitizer
  - Effective at killing organisms which cause disease
  - Strong oxidizer of perspiration, saliva, urine, body oils & wastes
  - Disadvantage: Combined chlorine (chloramines) causing "chlorine odor" and eye irritation

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Combined Chlorine

- Chloramines are formed when chlorine and the following combine:
  - Organic waste
  - Body waste (urine)
  - Particulate matter
  - Perspiration
  - Oils and lotions
  - Nitrates
  - Ammonia

Hence – COMBINED CHLORINE!

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Combined Chlorine

Lincoln Water System

2020 Annual Drinking Water Quality Report

...The next step is vital to protecting the health of our community. Once the water passes through the filters, small but exact amounts of chlorine and ammonia are added. These chemicals combine to form a disinfectant called "chloramine," which limits the growth of bacteria in the City's water distribution pipes.

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Combined Chlorine

- Use your test kit to check for combined chlorine
  - STATE LAW - Combined chlorine shall not exceed 0.5 ppm (Closure Item!)

Photo: LLCHD

136

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Combined Chlorine

Eliminate Combined Chlorine

- Breakpoint chlorination -- "Shock"
  - Dramatically increasing chlorine levels over the breakpoint dose for a short period of time completely oxidizes combined chlorine
  - Minimum amount of chlorine needed to remove combined chlorine
  - Adding less than the breakpoint dosage can create more combined chlorine

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Combined Chlorine

Eliminate Combined Chlorine

SHOCKING...SUPER CHLORINATION

- Breakpoint = 10 X Combined Chlorine Level

Example: Water test indicates
0.8 ppm combined chlorine
10 x 0.8 = 8.0 ppm

Solution: Add 8 ppm MORE chlorine than what the pool is currently at.

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Combined Chlorine

- Minimize combined chlorine – by being proactive
  1. Require patrons to shower with soap before entering facility
  2. Maintain a high free chlorine level 5-10ppm (combined chlorine may not accumulate)

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Combined Chlorine

- Other options to deal with Combined Chlorine
  - Drain the pool or spa
    - Fresh water always helps
  - Add ozone or UV
    - Many pools have had success with UV
    - Must submit plans and specs
  - Switch to Bromine
    - Must submit plans and specs

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Stabilized Chlorine

Stabilized Chlorine

Stabilizer-cyanuric acid

- Protects chlorine from sun
- Maintain at 25-40 ppm
- Do not exceed maximum ppm
- Lower by dilution
- Trichlor and Dichlor are the two types of stabilized chlorine

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Cyanuric Acid

Stabilized Chlorine

Stabilizer = cyanuric acid

>50 ppm lowers chlorine efficacy and may result in...

- Chlorine Lock
  -Chlorine is now useless
- Affects ORP
- Affects water clarity

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Stabilized Chlorine

Use of Stabilized Chlorine in INDOOR POOLS??

- New indoor pools
  - NOT ALLOWED!!
- Existing indoor pools
  - Must switch sanitizer type when existing stabilized chlorinator stops working

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Questions????

144

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Water Testing Methods

Photo: Clip Art

145

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Water Testing

- Why test pool water?
  - Healthy environment for swimmers
    - Proper sanitation
    - Good water quality
  - It is REQUIRED!!!
  - Balanced water
  - Good water clarity
    - Control algae growth
  - Save money on chemical use and equipment maintenance
  - Valuable tool during complaints and lawsuits

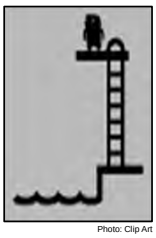

Photo: Clip Art

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Test Kit

- The test kit must be accurate and reliable to measure:
  - Free chlorine/bromine (FAS-DPD kit REQUIRED)
  - Combined chlorine
  - pH: (7.0-8.0 range)
  - Total alkalinity
  - Cyanuric acid – if used

Photo: LLCHD

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Water Testing

- The essential daily tests are:
  - Sanitizer
  - pH 7.2 to 7.8
  - Required before opening and every 4 hours until closing
- Weekly tests
  - Combined chlorine
  - Total alkalinity
  - Cyanuric Acid (if used)
- Recorded on log sheet

Photo: LLCHD

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Test Kit Reagents

- RECOMMENDATIONS – to get accurate results
  - Follow expiration dates
  - Store reagents away from other chemicals
  - Store reagents in a cool, dark location

Photo: NDEE

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Testing Procedures

- Testing procedures
  - Sample represents the entire body of water
  - Recommend using multiple sampling spots
  - Collect sample 12” to 18” below surface water
    - Not in front of inlets

Photo: LLCHD

150

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Testing Procedures

- Proper procedures
  - Rinse comparator tubes three times
  - Measure carefully
    - Pause between drops
  - Hold reagent tubes **vertical**

Photo: LLCHD

151

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Testing Procedures

- Proper procedures
  - Swirl…Swirl…Swirl (Invert for pH)
  - Do not shake the sample. It may affect the pH results.
  - Use cell caps. Fingers can contaminate the sample.

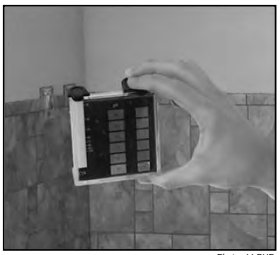

Photo: LLCHD

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Testing Procedures

- Proper procedures
  - Proper lighting will provide accurate readings
  - Read results against light background
  - Hold at eye level & measure from the bottom of the meniscus line

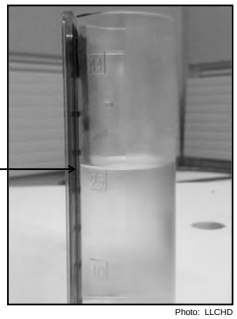

Photo: LLCHD

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Free Chlorine

- Free Chlorine (Example from Taylor Test Kit*):
  - Fill to either 10 mL or 25 mL line
  - Add 2 dippers R-0870 DPD Powder, Swirl
  - Add drops of R-0871 DPD Titrating Reagent, count and swirl each drop until color changes from pink to clear
  - Multiply drops
    - 10 mL sample: 1 drop = .5 ppm
    - 25 mL sample: 1 drop = .2 ppm
  - Example:
    - At 10 mL: 10 drops x .5 = 5 ppm
    - At 25 mL: 10 drops x .2 = 2 ppm

Photo: NDEE

*Other Test Kits are available and may have other instructions

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Combined Chlorine

- Combined Chlorine (Example from Taylor Test Kit*):
  - Immediately after the free chlorine test, with the same sample
  - Add 5 drops R-0003 DPD Reagent #3
    - If it turns pink continue, if clear no combined chlorine is present
  - Add R-0871 DPD Titrating Reagent, count and swirl each drop until color changes from pink to clear
  - Multiply drops
    - 10mL sample: 1 drop = .5 ppm
    - 25mL sample: 1 drop = .2 ppm

*Other Test Kits are available and may have other instructions

155

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Bromine

- Bromine (Example from Taylor Bromine Test Kit*):
  - Same procedures as chlorine…EXCEPT!
  - Multiply drops by:
    - 10mL sample 1 drop = 1.25 ppm
    - 25mL sample 1 drop = .5 ppm
  - Example:
    - At 10mL: 4 drops x 1.25 = 5 ppm
    - At 25mL: 4 drops x .5 = 2 ppm

*Other Test Kits are available and may have other instructions

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156

Bromine

- Bromine (Example from Taylor Chlorine Test Kit*):
  - Same procedures as chlorine…EXCEPT!
  - Multiply final chlorine number by: 2.25
  - Example:
    - Result of 5 ppm x 2.25 = 11.25 ppm bromine
    - Result of 2 ppm x 2.25 = 4.5 ppm bromine

*Other Test Kits are available and may have other instructions

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pH

- pH (Example from Taylor Test Kit*):
  - Fill to 44mL line
  - Add 5 drops R-0004 pH Indicator Solution. Secure the rubber cap
  - Invert 2 or 3 times to mix
  - Match color with color comparator

Photo: [illegible]

*Other Test Kits are available and may have other instructions

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Total Alkalinity

- Total Alkalinity (Example from Taylor Test Kit*):
  - Fill to 25mL line
  - Add 2 drops R-0007 Thiosulfate N/10, swirl
  - Add 5 drops R-0008 Total Alkalinity Indicator, swirl
  - Add R-0009 Sulfuric Acid, count and swirl each drop until color changes from green to deep red
  - Multiply drops
    - 1 drop = 10 ppm
  - Example:
    - 15 drops x 10 = 150 ppm

*Other Test Kits are available and may have other instructions

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Cyanuric Acid

- Cyanuric Acid Test (CYA) (Example from Taylor Test Kit*):
  - Fill CYA dispensing bottle to 7mL with pool water
  - Add R-0013 Cyanuric Acid Reagent to 14mL, mix for 30 seconds
  - Slowly add to small comparator tube until black dot disappears
  - Match liquid level with comparator on front

*Other Test Kits are available and may have other instructions

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Water Testing Problems

- During chlorine test, sample turns pink, but during swirling sample goes clear
  - Caused by very high levels of chlorine bleaching out the powder

Photo: LLCHD

161

161

Water Testing Problems

- Elevated chlorine, pH results might show a purple color instead of yellow to red range
  - Caused by high chlorine level interfering with phenol red reagent

Photo: NDEE

162

162

Water Testing Problems

- During alkalinity test, sample turns blue when alkalinity indicator is added and turns yellow when sulfuric acid is added
  - Caused by high levels of chlorine affecting the indicator
  - Fix by starting over and adding 2-3 more drops of thiosulfate

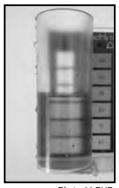
Photo: LLCHD


Photo: LLCHD

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INSTRUCTIONS ARE IN THE LID OF THE TEST KIT


Photo: LLCHD

Tests are color coded

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Pool Log

Pool log is a 1 year record of:

- Test results
- Chemistry adjustments
- Equipment maintenance
- Daily Patron loads

Keep current copy of Pool Operator Card and Water Tester Certificate on site!

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Results for Pool

- If.....
  - Chlorine is not between 2 ppm-10 ppm
  - Bromine is not between 2 ppm-18 ppm
  - pH is not between 7.2-7.8
  - Combined Chlorine is above .5 ppm
  - Cyanuric Acid exceeds maximum ppm

- **Close the Pool!!**

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Questions????

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Spas

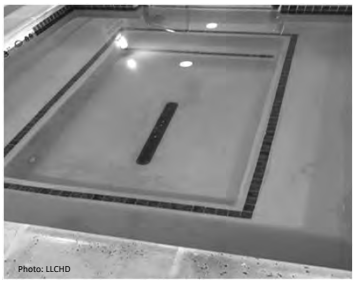
Photo: LLCHD

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Spa Timer

- Timer for hydrotherapy pump and air blower
  - should be beyond arm's reach

Photo: NDEE

169

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Spa Emergency Shut Off

- An emergency shut off switch located near the spa in case entrapment should occur
- Must shut down entire spa system

Source: NDEE

Photo: LLCHD

170

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Temperature

- Thermometers are required with spas
  - Does not need to be located in spa tub (usually on pipes)
  - **104º F Maximum**

Photo: NDEE

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Signage

4 inch lettering

TITLE 178 NAC 2, page 35

"No one under the age of 5 years is permitted in spa"

Photo: LLCHD

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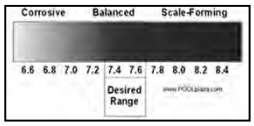
Spa Issues

- Air and hot water can cause pH to rise thus lowering the ability of the disinfectant to kill bacteria
- Smaller body of warmer water - more difficult to maintain water chemistry
- Frequent empty/refill affects pH - the actual pH level of water source



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Spa Issues

- Spa problems
  - hyperthermia
  - entrapment
  - Pseudomonas
  - dermatitis
  - ***Glass bottles!!***

Photo: CDC

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Spa Bacteria

- Spa bacteria
  - *Pseudomonas aeruginosa*
  - Likes 98º F – 105º F water temperature
  - *Legionellosis* and *Pontiac Fever*
- Pseudomonas can cause
  - Eye and ear infection "swimmers ear"
  - Skin and respiratory infection
  - Endocarditis – infects heart valves
  - Urinary and gastrointestinal infection

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Legionnaires Disease

- Caused by *Legionella* bacteria
- *Legionella* is naturally found in water—especially warm water. Hot tubs/spas that are not cleaned and properly disinfected, can become contaminated with *Legionella*
- A person can get infected when they breathe in steam or mist from a contaminated spa/hot tub
- Making sure the hot tub /spa has the proper disinfectant and pH levels are essential

Photo: LLCHD

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Recirculation of Spa Water

- 30 minute turnover
- Filtered
- Sanitized
- Heated
- Returned

➡ Air blower separate from water circulation

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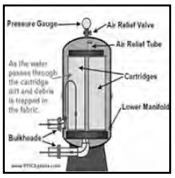
Filtration

- Water cleaned by cartridge or sand filter
- Back-up 2nd cartridge is required

Pool matrix



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Results for Spa

- If.....
  - Chlorine is not between 3 ppm-10 ppm
  - Bromine is not between 4 ppm-18 ppm
  - pH is not between 7.2-7.8
  - Combined Chlorine is above .5 ppm
  - Cyanuric Acid exceeds the maximum ppm

- **<u>Close the Spa!!</u>**

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Questions????

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TEST TIME!!!!!

- Open book/notes
- Must complete the test within 4 hours
- Must start online test within 24 hours
- Must score no lower than 70%

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- **Do not write on test booklet**
- **Darken the letter chosen**

YES

Source: DHHS

NO

Source: DHHS

182

182