Section 7: Recirculation and Filtration

Rationale:
Water circulation and filtration plays a key role in water quality and the prevention of recreational waterborne illness and physical injury. Effective and appropriately sized water pumps, flow rates within the recirculation system, and the appropriate filtration provide the following benefits:[107]

- An effective circulation system
  - ensures treated filtered water is delivered to all parts of the pool
  - delivers the water in a safe manner (without risk of entrapment)
  - ensures dirty water (particles and germs) are removed from the pool
- Effective filtration
  - removes particles that may shield microorganisms that will interfere with disinfection functioning
  - removes particles that will contribute to turbidity, which increases pool clarity and reduces the risk of failing to see a bather in distress under water
  - removes organic particles from pool water, preventing the production of disinfection by-products in the water and their release into the air
  - is crucial in the removal of Cryptosporidium oocytes and Giardia

[107] http://www.who.int/water_sanitation_health/bathing/srwe2chap5.pdf

Section 7: Recirculation and Filtration

7.1 General Recommendations

- The recirculation system and chemical feeders shall be designed and maintained to circulate and treat the water continuously throughout the entire pool 24 hours each day, regardless of the actual use time of the pool, except when maintenance, repairs, and backwashing are being done.
- Flow through the various components of a recirculation system shall be balanced according to maximize the clarity and safety of a pool.
- For gutter or skimmer pools with main drains, the required recirculation flow shall be as follows during normal operation:
  - at least 80% of the flow through the perimeter overflow system
  - no greater than 20% through the main drain

7.2 Circulation, Chemical Feeders and Filtration Recommendations [108]

- equipment is to be maintained and function as intended and designed
- operational manuals for all equipment shall include operating, cleaning, installation,and maintenance instructions and these details shall be incorporated into the standard operation procedures of the Aquatic Safety Plan and be on site
- appropriate training of all staff in the operation, maintenance, and repair of equipment and/or a list of appropriate professionals (e.g., certified electrician) named in the Aquatic Safety Plan where required

7.2.1 Surface Water Removal (Skimmers)

Rationale:
Overflow system (gutter) and skimmers are two methods used for surface water removal in filtering, disinfection, and recirculation of water to the pool. If these become blocked or if they are broken it will lead to ineffective circulation and disinfection and may become a suction entrapment risk for patrons.

Operational Recommendations:

- Surface water removal systems shall be designed, installed and operated not to create a hazard to the user.
- The overflow systems shall be kept clean and free of debris that may restrict flow.
- The automatic fill system shall maintain the water level at an elevation such that the gutters shall overflow continuously around the perimeter of the pool.
- The automatic fill system shall maintain skimmer water levels near the middle of the skimmer openings when the pool is unoccupied.
- The flow through each skimmer shall be adjusted as often as necessary to maintain skimming action that will remove all floating matter from the surface of the water.
- The strainer baskets for skimmers shall be cleaned daily.
- Broken or missing skimmer weirs/covers shall be replaced immediately. (See also Section 7.3, Preventing Suction Hazards in Pools and Spas.)
- A flotation test may be required to evaluate the effectiveness of surface skimming.

[108] NSF/ANSI 50-2012

Section 7: Recirculation and Filtration

7.2.2 Piping and valve system

Rationale:
A pool's piping and valve system is an essential component to the circulation system. Being able to identify the pipe being used for a particular function when maintenance is required will ensure worker safety and effective preventative maintenance.

Recommendations:

- All piping shall be non-toxic and be able to withstand the design operations pressure.
- Pipes shall be colour coded, labeled, or tagged for clear identification to aid in pool operation, maintenance, and safety. Components that shall be clearly identifiable include, but are not limited to
  - chlorine lines and pipes carrying chlorinated water
  - other chemical lines
  - potable water lines
  - flow of water in the pipe
  - filtered water lines
  - backwash lines
  - heated water lines
  - valve, meter, and pressure gauge identification

7.2.3 Pumps and Strainers

Rationale:
Circulation pumps provide the power to enable the water to move through the circulation system. If these are not sized appropriately and provided with preventative maintenance, the pumps will not work or will not be effective leading, to pool closures.

Recommendations:

- Pumps shall be sized to suit the water circulation system of the pool to ensure it is capable of providing the flow required for filtering the pool water and filter cleaning, if applicable, against the total dynamic head developed by the complete system.
- Pumps shall be provided with preventative maintenance.
- Pumps shall be equipped with appropriate and accessible (pressure) gauges.
- Strainers shall be in place and cleaned as required to maintain pump performance.
- Emergency shut-off switches shall be maintained and inspected to ensure the circulation power can be stopped in case of emergency.

7.2.4 Pool design flow rate

The flow rate of a pool is measured in gallons per minute (or L/min) and is the rate of water movement within the circulation system. There shall be sufficient flow rate to achieve required turnover rates.

Flow Rate = Pool volume/Turnover rate/60 min/hour

7.2.4.1 Turnover rate and flow rates

Rationale:
To ensure water clarity and prevent recreational water injuries, the volume of pool water shall continuously be removed from the pool, filtered, treated, and returned to the pool. This does not happen completely in one turnover. Instead it is done through dilution and so it will take several turnovers to ensure the entire body of water is moved through the filtration and treatment system. The pool type (design) and potential contamination load play a key role in designing turnover rates. It is essential the flow rate and circulation system does not allow for any stagnant spaces in the water or suction hazard concerns.

The turnover rate is calculated in hours and is the time it takes for the volume of pool water to be filtered, disinfected, and returned to the pool:

Turnover rate (hours) = Pool volume / Flow rate / 60 min/hour

Table 9. Turnover Rate (hours): Quick Reference Chart

Recommended Turnover Rates by Pool Type [109, 110, 111]								
Pool type	Swimming Pool	Wave Pool	Wading Pool*	Water slide/ Receiving Pool/Plunge	Whirlpool spa	Activity Pool (>2 ft)	Lazy River Pool	Run-out slide
After major renovation or built after 2014								
Turnover max rate	6 hours	2 hours	1 or less hour	30 minutes – 1 hour	30 minutes	2 hours	2 hours	1 hour
Before 2014 Guideline								
Turnover max rate	6 hours (4 in 24 hours)	N/A	4 hours (6 in 24 hours)	N/A	30 minutes	N/A	N/A	N/A

* Would benefit from secondary disinfection

Resource:
An increase in turnover rate will mean an increase in the flow rate. A decrease in turnover rate will produce a decrease in the flow rate. This is an important relationship to understand from an operational and safety perspective. A drop in flow rate may indicate the filters need to be cleaned (backwashed/maintenance performed), skimmers need cleaning, and/or water pump issues. If the flow rate is too high for equipment capability including covers it may present a suction entrapment hazard due to an increase flow in the circulation system. See Section 7.3, Preventiing Suction Hazards in Pools and Spas.

[109] Comparison of various Provincial Pool Guidelines including those in draft form
[110] The USA Centre for Disease and Prevention. (2014) Model Aquatic Health Code-First Edition The Code
[111] ANSI/APSP-9 2005 Standard

7.2.5 Flow meters/Pressure and Vacuum Gauges

All pools and spas shall be equipped with a flow metering device that indicates the rate of flow through the filtration system. Where a single treatment plant serves two or more separate pools, provisions shall be made for measuring the flow into and from each pool. Ideally all pools shall have separate circulation and filtration systems.

Recommendations:

- Every pool shall be equipped with, and staff trained in, the flowmeter device or other industry-specific device used to determine flow rate (electronic or analog).
- The device shall be accessible for ease of viewing and servicing.
- The device shall be appropriately calibrated.
- The Aquatic Safety Plan shall stipulate the design flow rate and readings shall be checked and recorded daily.
- Skimmers and baskets shall be cleaned of debris daily or more often if required.
- Drain covers shall be properly sized to the design flow rate.
  - The flow rating of the cover must exceed the maximum achievable flow by the pump when all the circulation valves are fully open, and with a clean filter, strainer, and skimmer baskets. This is an important aspect of suction entrapment hazard mitigation.

7.2.6 Filtration

Rationale:

Filtration plays a key role in cleaning the pool water by filtering out (trapping) contaminants in the filter media. There are a variety of types of filters and filter media utilized in industry including sand filters, diatomaceous earth filters, and cartridge filters. Without proper maintenance, filters can become clogged, reducing flow rates, and can become a source of pool water contamination.

Recommendations:

- All pools that recirculate water require filtration.
- All filters shall be certified to BSF/ANSI 50.
- The operator shall be trained in the use of the various settings, valves, gauges, and procedures of the filtration system including filter, recirculate, backwash, cleaning, replacement and drain.
- A qualified operator shall inspect other granual filters for proper depth and cleanliness at least once each year, replacing the media when necessary to restore depth or cleanliness.
- One full set of spare cartridges (when used) shall be maintained on site in a clean and dry condition.
- Diatomaceous earth (DE), when used, shall be added to precoat filters in the amount of 1 to 2 pounds (0.45 to 0.91 kg) per 10 square feet of filtration surface area unless more is recommended by the filter manufacturer and the filter is certified to NSF/ANSI 50 by an ANSI-accredited certification organization for a higher precoat media dosage rate.
- Perlite, when used, shall be added to precoat filters in a minimum amount of 0.5 to 1 pounds (0.23 to 0.45 kg) per 10 ft^2 (0.93 m^2) of filtration surface area unless more is recommended by the filter manufacturer and the filter is certified to NSF/ANSI 50 by an ANSI-accredited certification organization for a higher precoat media dosage rate.
- Ensure filter flow rates are maintained as designed and that they can achieve the pool's turnover rate.

Table 10. Commonly Accepted Media Rates[112]

Filter Type	Filter Media Rate	Filter Type	Filter Media Rate
High Rate Sand	5-20 gpm/ft^2 204 -813 lpm/m^2	Cartridge	0.375 gpm/ft^2 15 lpm/m^2
Diatomaceous Earth	2.0 gpm/ft^2 81 lpm/m^2	Diatomaceous Earth with Slurry	2.5 gpm/ft^2 102 lpm/m^2
Rapid-Sand Filter	3gpm/ft^2 122 lpm/m^2		

7.2.6.1 Filter backwashing/cleaning and replacing

- As per manufacturer's instructions.
- Filter backwashing shall occur when the water entering the filter and the water exiting the filter reaches a 10 to 30 psi difference in the pressure gauge.
- If there is only one pressure gauge then backwashing shall occur when the pressure increases by 8 to 10 psi.
- Filter backwash lines, deck drains, and other drain lines connected to the aquatic facility or the aquatic facility recirculation system shall be discharged through an approved air gap.
- Also see manufacturer operating instructions for guidance.

7.2.7 Surge tanks

Rationale:
Proper maintenance will reduce the chance of biofilm formation and bio-corrosion.

Recommendation:

- Surge tanks shall be provided with a means for complete draining to allow for routine inspections, maintenance, and cleaning.

7.2.8 Inlets

Rationale:
Inlets deliver water and play a key role in the circulation pattern and mixing of swimming pool water. A blocked, broken, or plugged inlet will interfere with this process and affect water quality.

Recommendations:

- Ensure all inlets are functioning at the capacity and as designed to ensure circulation pattern and mixing of swimming pool water.
- Methods of testing include
  - ensuring that disinfection levels in various locations of the pool are consistent
  - performing a dye test
  - physically feeling if water flow exits from inlets

[112] NSF/ANSI 50 – 2012

Section 7: Recirculation and Filtration

7.3 Preventing Suction Hazards in Pools and Spas [113]

Rationale:
Suction has been the cause of preventable deaths and severe injuries in swimming pool facilities worldwide. Water outlets can cause suction that is strong enough to entrap body parts or hair, causing a bather's head to be held under water, leading to drowning. In addition, there have been reports of incidents in which the suction from the pool and spa drains or pool water play features is strong enough to disembowel a swimmer. Any drain that the body can cover completely, combined with a plumbing layout that allows a build-up of suction if the drain is blocked, can present this hazard.

> **Note:** The term anti-vortex should not be interpreted to imply an anti-entrapment device and does not impart any protection. It should no longer be referenced in this regard.

Unblockable drain: a drain of any size or shape that a human body cannot sufficiently block to create a suction entrapment hazard.

7.3.1 System evaluation and routine maintenance

Operating procedures including system evaluation, inspection, routine maintenance, and procedures for suction- and entrapment-related emergencies that ensure water leaving and returning to the pool does not create suction or entrapment hazards shall be developed and be clearly outlined in the Aquatic Safety Plan.

A complete set of pool drawings shall be available and on-site for easy reference by pool staff. Manuals for the operation and maintenance of the pool as well as technical data sheets shall also be available at the pool. These manuals

- should provide complete and thorough information from the manufacturer regarding maintenance needs of suction points
- are updated as required
- include information from the pool architect/designer regarding potential hazards
- will have operating records maintained to provide information regarding make and model, purchase date, and expiry date of suction outlet covers, and manufacturer's flow rate

System evaluation and routine maintenance shall be done to ensure that suction fittings and inlets are secure and in good repair. The qualified person(s) shall ensure

- suction points are designed to prevent a person from being held onto the suction point
- that system tests shall comply with ANSI/APSP-16 2011 or the most recent version of this standard
- that inlet fittings are designed to prevent entrapment
- that when fasteners are used the suction fitting shall be designed to require tools for disassembly preventing patrons from removing the fitting

[113] Saskatchewan Ministry of Health, Swimming Pool Design and Operational Standards
[114] Alberta Public Health
[115] U.S. Consumer Product Safety Commission (CPSC),Pool Safely, The Pool & Spa Safety Act, http://www.poolsafely.gov/faqs

- the pool has and maintains skimmers or gutters designed to prevent entrapment
- that each main drain
  - is located at, or as close as possible to, the deepest part of the pool basin
  - is covered with a grate that cannot entrap a person or be readily removed
  - has approved drain covers that are sized to have the appropriate flow rates
- that circulating pumps have an effective vacuum-breaking design measure
- that no equalizer lines terminate in the pool basin
- that submerged equalizer lines or equalizer fittings in the pool, if they exist, are disabled/deactivated

7.3.2 Installation and update

Installation of anti-entrapment fittings:[114]

Anti-entrapment fittings shall be installed in accordance with the manufacturer's instruction, and be maintained in good working order when the pool is available for use.

Every submerged suction outlet shall have at least one of the following:

- a cover that complies with performance standards of American National Standard for Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs (ANSI/APS-16 2011 or the most recent version), and is installed, maintained, and tested according to manufacturer's instructions
- a custom-fabricated cover that is constructed and certified by a professional engineer, and installed and maintained according to an engineer's instructions
- every equalizer line outlets shall have a cover that complies with ASME A122.19.8-2007, or be permanently disabled
- every vacuum outlet shall have a cover and be used in a manner that prevents bather entrapment

Single-submerged suction outlet that is blockable[115]

Pools that have a single submerged suction outlet that is blockable shall employ at least one of the following additional options that is approved by a professional engineer and be documented as such in the Aquatic Safety Plan:

- conversion to a multiple suction outlet system with at least two fully interconnected submerged suction outlets at least 3 feet apart (900 mm) from centre to centre for existing pools and 3.3 feet apart for new pools, or
- installation of a safety vacuum release system (SVRS) that relieves suction when blockage is detected and that is installed to meet the performance standards of ASTM F2387 and/or ASME/ANSI A112.19.17s, or
- installation of a properly designed and tested suction limiting vent system that meets ASME-A112.19.17, or
- installation of an automatic pump shut-off system which meets ASME-A112.19.17, or
- permanent disablement of the submerged suction outlet either by reversing the flow through the fitting or completely sealing the existing outlet when the skimmer is capable of providing for 100 percent flow, maintaining acceptable turnover rates, or installation of an equivalent system approved by a professional engineer.

[114] Alberta Public Health
[115] U.S. Consumer Product Safety Commission (CPSC),Pool Safely, The Pool & Spa Safety Act, http://www.poolsafely.gov/faqs

Vacuum Suction Outlet

A submerged suction outlet used for vacuuming shall have a cover to reduce the risk of entrapment, and be used in a manner to protect the bather from entrapment or from being permanently disabled.

7.3.3 Inspection and closure

Covers of each submerged outlet shall be routinely inspected every day before pool/hot tub opening. If cracked, broken, or missing, the pump shall be immediately shut down and the pool/hot tub will remain closed.

> The pool or hot tub shall be closed immediately if any suction fitting is found to be damaged, defective, or missing.

7.3.4 Procedures for suction- or entrapment-related emergencies[116]

Recommendations:

The Aquatic Safety Plan shall identify procedures to be followed to free someone who has become trapped or held against a suction point. It is recommended that pool owners train staff to

- shut down the pumps immediately if someone becomes trapped
- ensure scissors are readily available that can be used to cut hair that has become entrapped
- have established procedures for draining the pool
- have in place any other procedures necessary to free a person trapped underwater

[116] BC Pool Operator Guidelines