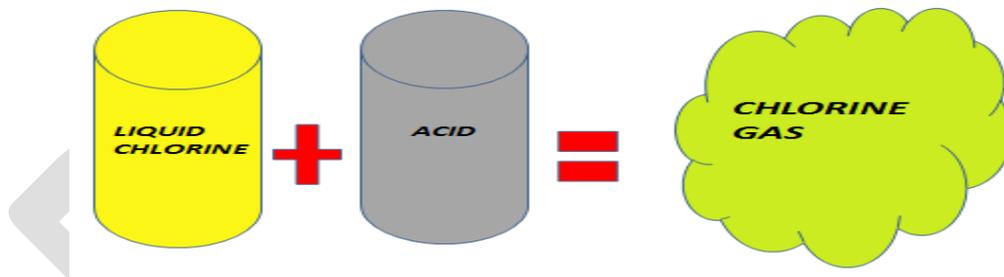


CHLORINE OFF GASSING AT PUBLIC SWIMMING POOLS

Chemical reactions can cause various hazards, including poisonous fumes, caustic liquids and even explosions. Chlorine and acid are incompatible chemicals necessary for proper pool disinfection. Improper and uncontrolled mixing of the two can likely yield dangerous chlorine gas, yet pose minimal risk when dosed separately and rendered comparatively harmless when diluted by the vast amounts of pool water. Exposure to chlorine gas can result from manual or hand mixing of incompatible chemicals, typically within the chemical room, and may result in vapors traveling into the pool as well as other common areas. Exposure can also result from liquid chlorine and acid being inadvertently drawn, mixed, and then accumulated within the pipework when circulation or flow has ceased from an inactive pump. Therefore, when power to the pump is eventually restored, a release of the yellowish-green gas occurs abruptly within seconds after flow is reinstated, with the chlorine gas entering the pool through the pool return inlets. Any disruption to flow or pool circulation must likewise interrupt chemical feeding to prevent a potential chemical build up within the pipework.



Cause and solution

Without power to the pump, there can be no flow through the pipes. The unwanted blend of chlorine and acid starts with disruption to power, both deliberate (during routine equipment maintenance) and unintended (during power outages). When power is restored, certain pumps (particularly those with integrated starting features) will not automatically restart to safeguard against damaging the pump. On the other hand, the chemical feed pumps and chemical control system are not always equipped with such features, causing both chlorine and acid pumps to re-start – injecting acid and chlorine into the pipework of stagnant water without flow. As such, the chemical feed pumps and the chemical control system must be equipped with safeguards against indiscriminate feeding, which at a minimum should include an electrical interlock between the chemical control system and the starting controls of the pump in addition to establishing a link between chemical dosing and pump failure. However a pump running under cavitation with loss of prime could stop or limit the circulation flow, yet fail to restrict the chemical pumps from continual feeding. To overcome this complication, supplemental *flow switches or sensors* relayed to

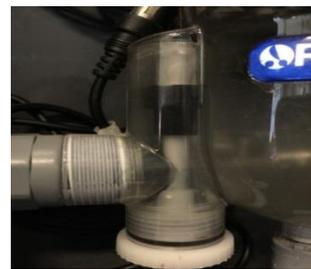
the chemical dosing equipment should serve to disrupt chemical feeding upon loss of circulation flow. This would require routine testing of flow switches to be performed since switches in general may not always be reliable. The installation of two or more redundant switches can further reduce the possibility of failure.



Rotary Flow Switch



Paddle Flow Switch



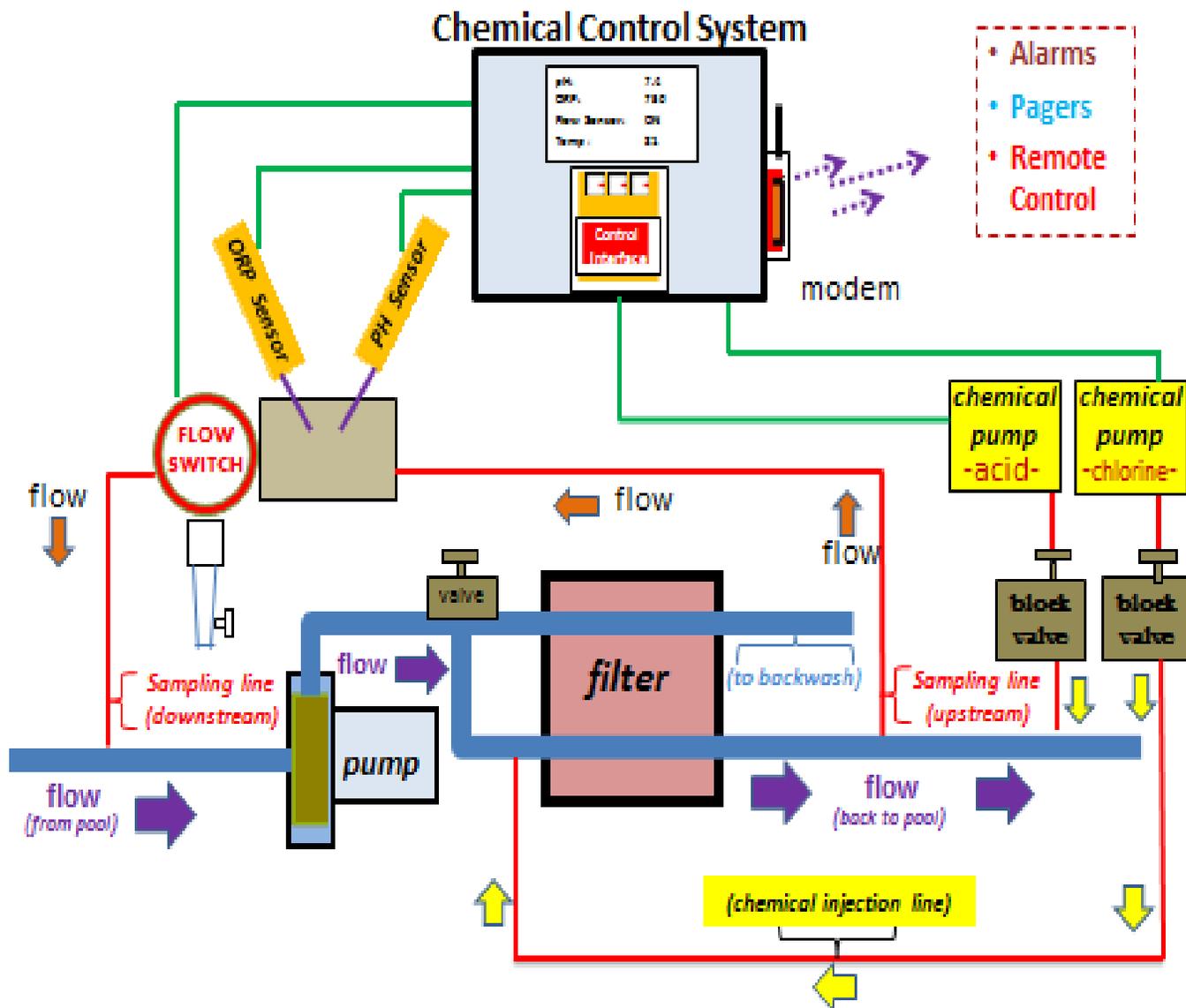
Bobbing Float or Magnetic Flow Switch

Equipment safeguards

Equipment will vary and differ in features, capabilities, appearance, and repair. Operation and routine testing in accordance with the manufacturer's specifications are critical to ensure adequate performance. Malfunctions must be averted to prevent incompatible chemicals from mixing.

- **Chemical pumps and feeders** are responsible for chlorine and acid delivery and can vary from relatively simple with minimal parts and components, to more elaborate mechanisms. Peristaltic pumps apply rollers that squeeze a feeding tube, grabbing the liquid chemical through the tube. Erosion feeders can be used for feeding dry chemicals by applying the water stream through the pipework to dissolve the dry chemical tablets or granules. A diaphragm or piston pump functions with a motorized cam and series of check valves. One contributing factor to failure could result from contaminants (sand or grit) lodged within a valve. To minimize the blending of chlorine and acid, installing the chlorine injection line before (upstream) the filter, with the acid injection line after (downstream) filter – is suggested to reduce the risk of merging both chemicals. If this isn't possible, the injection points should be at a minimum of 10 pipe diameters apart. Chemical **tubing** is also subject to wear and deterioration and can only be replaced with an equivalent specifically intended for the chemical feed pump. Given the variation in moving parts and components, periodic testing and maintenance is highly recommended.
- **Anti-syphon valves** in the chemical feeder pumps are highly recommended and may be required by the chemical pump manufacturer. If chemical containment vessels, injection points, pipework, and filtration are located above the pool, liquid contained within the system above the pool water level may drain back into the pool and moreover syphon or draw both chlorine and acid into the system pipework.
- The installation of **flow switches** or any electrical component and corresponding relays require methods approved and intended by the manufacturer. Repairs or alterations to electrical devices, associated components, and equipment must sustain compliance with the National Electrical Code (NEC), or with applicable local codes. The installation of such items or fail-proof features including flow switches, may fall outside the scope of Environmental Health and may require further consultation and approval from the local Building Authority.
- The **chemical control system** dictates how much and when to feed chemicals to the pool. These systems are typically equipped with a flow switch and an integrated alarm, intended to prevent

chemicals from feeding with interrupted flow and should operate continuously. However power outages may cause disruption and possible malfunction of system parts and components. Following a power outage, consult with a service professional with chemical control system expertise for further evaluation of the chemical controller.

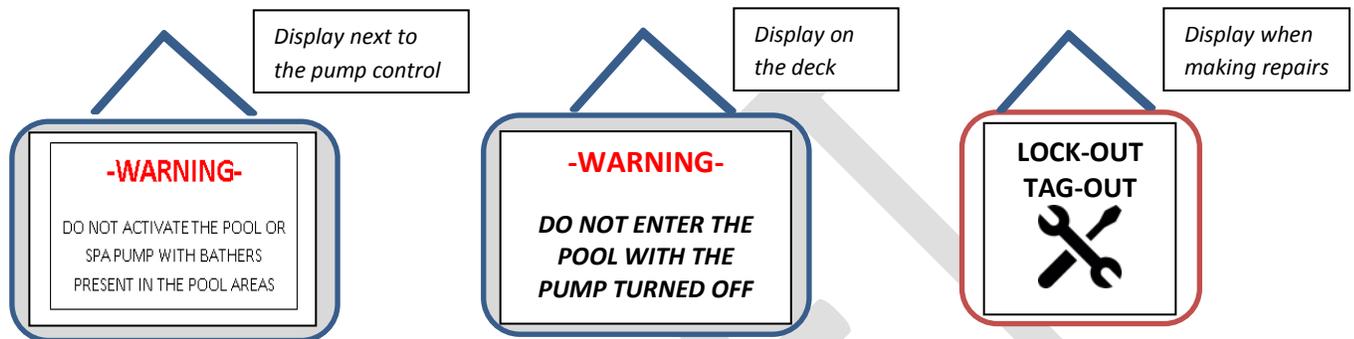


Procedural safeguards

Strategies beyond equipment design should be implemented to further reduce any likelihood of unwanted chemical releases, and should include routine testing of the chemical control system. Manual water sampling of the chlorine and pH levels using a separate test kit can be performed to compare chemical reading accuracy with the chemical control system. The flow switch and alarm should also be tested periodically according to the system manufacturer. When performing maintenance, service repairs, or any work to the chlorination or chemical feeding system, isolation of the chemical feeders from the rest of the water circulation system with closing block valves – should be fulfilled in conjunction with standard

procedures for *lockout-tagout (LOTO)*. The locked unit is then tagged with an inscription identifying the worker who has placed it. This prevents accidental startup and unintended chemical feeding from the unit. Chemical containers and tubing should also be color coded and labeled accordingly to prevent accidental mixing.

Contingency planning is strongly recommended with an emergency action plan that includes a protocol to evacuate the pool after a pump failure, with safeguards against reentry – including *safety signs displaying warning announcements not to enter the pool with an inactive pump*. Additional signs should be posted announcing this requirement. The plan should have further measures against chemical off gassing disasters and be site specific and customized to meet the needs of the facility.



EMERGENCY ACTION PLAN

An effective emergency response plan begins and ends with good management and supervision. Planning will include procedures for emergency situations, reporting requirements, restoration of facility operations, implementing practice drills, and performing self-inspections; all of which should be incorporated into a written emergency action plan. The written plan should be specifically developed and tailored to characteristics unique to each facility. If your swimming pool has a permit from your local Hazardous Materials Programs due to the quantities of hazardous material(s) stored at your facility, you likely have already prepared an Emergency Action Plan.

Consult with service professionals with expertise in developing emergency action plans specific to public pools. Local hazardous material and fire personnel should be consulted for issues pertaining to chemical storage. Once complete, put the plan into action. Emergency drills should be practiced routinely.

Emergency Response

Dangerous situations can vary. Irrespective of risk level, any situation with imminent hazards jeopardizing health and safety can be considered an emergency. Applying the following countermeasures in response to emergencies is recommended:

1) Manage the emergency

- Coordinate with staff and confirm your mode of communication. Effective communication is essential.
- Develop a chain of command as part of your emergency response plan. Phones must be available and conveniently located. Emergency phone numbers must be prominently posted. A method of communication between staff using whistles or hand signals should also be established.

- Develop a contact list prescribing assignments and responsibilities.

2) Assign Responsible Staffers

Designate staff members for emergency situations. Assignments should be relegated according to skill. For instance, lifeguards are better qualified to perform emergency rescue than the facility manager. Likewise, the facility manager may be better equipped to report incidents and supervise exercise drills. Assign staffers for each of the following actions:

- Emergency rescue and first aid to injured parties (typically performed by lifeguards).
- Immediate contact of emergency personnel (local fire and rescue).
 - Search for lost patrons or pool users: Time can be crucial when searching for a lost bather, particularly for large scale facilities with multiple patrons. Get a description of the missing individual with last location seen and immediately search the water and facility grounds. Lifeguards are trained on search methods which can vary and should be site specific depending on facility characteristics. Establish lifeguard search procedures specifically tailored for your site.
 - Initiate closure of the facility. Begin evacuation and clearing procedures and install closure signs at all entrances.
- Direct traffic
 - Crowd control: Usually a large number of people congregate at the scene of an emergency. The emergency plan must include clearing the incident area and crowd control with on-going supervision of the facility.
 - Meeting and guiding emergency personnel to the site and/or injured party. During an emergency it's extremely important to provide rescue personnel with detailed directions to your bathing facility. Access for emergency personnel should be evaluated with routes determined in advance.

Reporting Requirements

Any drowning, chemical injury, waterborne illness, and rescue requiring resuscitation or medical facility attention will require reporting to Contra Costa Environmental Health as quickly as possible but **within 24 hours**.

- Produce records indicating the number of pool users, all lifeguards on duty, water characteristics, equipment maintenance including failures and malfunctions.
- These records must be available for review by the Permit Issuing Official for at least 2 years.

Restoration of Facility Operations

Depending on the state and complexity of the operations, consultation from service professionals may be necessary to evaluate all system operations prior to resuming reopening. Equipment function and water characteristics must be restored. Regulation components and automation systems must be assessed and adjusted accordingly. Keep inventory record and data of all incident situations including written assessments with corrective measures taken by you and consultant or service professional.

Practice Drills

Practice makes perfect and training is essential for emergency response situations. Staffer members assigned to emergency response must be trained. Provide training with frequent practice to reinforce the principles and routinely rehearse the plan.

- Practice emergency response drills including passage routes for directing emergency personnel.
- Practice lifesaving skills to sustain proficiency in performing rescues.
- Practice search procedures for lost bathers.
- Practice flashlight distribution for staff, applicable to indoor pools or pools open at night, without the presence of natural night.
- Practice all other response protocols; site specific and tailored for your facility.

Self-Inspections

Ensuring good facility maintenance will minimize equipment failures, disruptions, and reduce delays during emergencies. To help ease your response to emergency situations, perform compliance checks of your own accord. Develop an inspection checklist or adapt the inspection report issued by Contra Costa Environmental Health to identify the wide range of health hazards including unsafe water conditions, broken equipment, inadequate safety signs, missing rescue devices, electrical equipment malfunctions, broken/loose suction outlet covers, missing first aid kits, broken gates and fences, etc. Take action to correct any deficiencies. Close the pool, restrict public access, and post closure signs when encountering imminent health hazards that can't be corrected.

After the emergency

Preparing for an emergency is extensive and includes many responsibilities. Proficiency in record keeping, retaining reports, reassessing and replacing equipment are few of the multiple issues to deal with. Staff debriefing should be implemented following the emergency. For further information on developing an emergency response plan, consult with industry professionals and refer to the following online resources:

<https://emergency.cdc.gov/>

<https://nspf.org/>

<https://apsp.org/>