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BY DR. ALISON OSINSKI

The Villa Portofino community pool receives heavy use during the summer months. Recent equipment problems led to the hiring of an outside consultant for advice.

Hidden Problems — A Step-by-Step Guide to Pool/Spa Equipment Room Troubleshooting

Recently, one of the largest self-managed residential associations in San Diego County, Calif., experienced problems with the equipment at its outdoor swimming pools. A professional management company had not been retained to oversee the operation and administration of the association properties and facilities, and the smooth operation of the facility hinged on the interest and persistence of active board members.

Villa Portofino is a planned residential development. The community is approximately 20 years old and consists of 721 unattached units set among 640 eucalyptus trees. The association maintains a six-acre park, 13 common areas and 52 alley walkways. Amenities include a playground; picnic area; basketball court; four tennis courts; a clubhouse with an office, kitchenette and meeting rooms; and a swimming pool, spa and children's wading pool. As is typical for Southern California, the pools are located outdoors and are open for use by residents and their guests throughout the year. The 148,000-gallon main pool is rectangular, approximately 75 feet by 45 feet with a maximum depth of 9 feet.

Members of the Villa Portofino Board were concerned about the need for frequent replacement of pool equipment. According to Kelli Fox, Villa Portofino administrator, the board became aware that there was a problem when a 2-year-old natural gas heater needed to be replaced again. Costs had been amortized over a period of 10 years — the estimated life expectancy of the heater — and the board was concerned when the heater deteriorated so rapidly. Also, a recurring black algae problem was plaguing the pool. "We had been told by a heater repairman that we were using too much chlorine in the pool and that the chlorine had destroyed the heater," she said.

According to Charlotte Bell, recreation chairman, "Another serviceman told us the heater disintegration was due to improper location of the chlorinator and high levels of chlorine going through heater elements. We thought we were getting proper advice and good service from our independent pool serviceman. We assumed he knew what he was doing."

Mary McCarroll, association president said, "Too many unqualified experts were giving us conflicting advice." As a result, a pool committee composed of board members and concerned residents was formed to determine if the pool equipment was being properly maintained.

"We had cost, liability and health concerns about what was happening in the pool area," Fox explained. "It became difficult to trust what was being told to us by servicemen and equipment suppliers. They all seemed to want to sell us something. We had been given bad or conflicting advice on several occasions."

Bell knew the board was frustrated in not knowing what to do or how to solve the problems in an economical way. She did not want to repeat a past board mistake of letting in-house maintenance and landscaping employees install and maintain pool equipment in the guise of saving a little money. She also was concerned about the conflicting information being given by pool professionals.

An avid swimmer herself, McCarroll just wanted to get the pool fixed in a timely manner. She bought into the complex because of the amenities, particularly the swimming pool. "The association has a responsibility to maintain common areas in good condition. Common areas and amenities attract new buy-

TROUBLESHOOTING REPORT — VILLA PORTOFINO COMMUNITY
Tierra Santa, Calif.

PROBLEM	SOLUTION
• Pool heater installed improperly and had disintegrated	• New natural gas heater was installed by a knowledgeable vendor
• Acidic chemicals being injected in wrong place	• Chemical injection equipment was relocated to the correct position
• Black algae, poor pool water circulation and low turnover rate	• Changes were made to improve the circulation pattern in the pool, eliminate dead spots and lessen the likelihood of uncontrolled black algae growth. A pool blanket was added
• Recirculation pipes were undersized and were restricted due to corrosion	• Some circulation pipes were replaced
• Total dissolved solids (TDS) and cyanuric acid levels were too high	• Primary bactericide was switched from trichlor to sodium hypochlorite. Pool water was drained to lessen the levels of TDS and cyanuric acid
• No handicapped access	• A ramp entrance was added for ADA compliance
• Deck slippery with puddles of standing water	• Puddling and drainage problem corrected; pool deck was acid-etched to lessen the likelihood of slip-and-fall accidents

ers and increase the value of the property," she said.

At this point, the board made a decision to call in an aquatic consultant to conduct a pool site inspection and determine what really needed to be done. Members did not feel they had enough experience to decide which vendor really knew what he was doing and what modifications to the facility or equipment repairs were really necessary. "We wanted someone who did not have a financial interest in what they told us we needed to do. We wanted options from an unbiased source on how to best correct our problems," Fox said.

During a typical pool site inspection, observations are made on the condition of the facility as a whole, including:

- Thorough inspection of the pools, decks, equipment room, chemical room, locker rooms, storage areas, auxiliary areas and all related equipment;
- Review of records pertaining to the past maintenance and operation of the facility;
- Notation of hazards or potential hazards at the facility;
- Chemical analysis of water and air samples;
- Startup of the circulation system and check of proper flow rate and turnover rate time;
- A sodium fluorescein dye test to determine pool circulation patterns and inlet operation;
- Measurement of the facility and comparison with construction diagrams and specifications; and
- Identification of violations of existing codes, regulations or common and acceptable standards of the industry.

From this examination, a report on the condition of the aquatic complex is generated. Recommendations on modifications, system upgrades and replacement of equipment based on current technology and existing codes are made. Modifications to improve the safety and operational effectiveness of the filtration and hydraulic systems and the pool's chemical systems are recommended. Recommendations also are made to reduce risk and eliminate safety hazards and help clients better meet the needs of their patrons by operating a safer and more efficient aquatic facility.

The results of the Villa Portofino pool site inspection confirmed the board's suspicions:

- The equipment room was poorly designed, laid out and maintained.
- Equipment was not adequately labeled.
- Schematic diagrams and manufacturers' operations and maintenance manuals were not available for reference.
- The pool heater had disintegrated, primarily because of improper heater installation and injection of acidic chemicals, particularly trichlor, immediately prior to the heater elements.
- Turnover time was much too low, and pool water was not circulating at the required rate.
- Recirculation pipes were undersized for carrying the required flow of water from the pool, and alternating oversaturated and aggressive water conditions combined with long-term maintenance of unbalanced water conditions caused flow of pool water through the pipes to be further restricted.
- Hydraulic system calculations had not been done correctly. The centrifugal force pump was not capable of overcoming friction losses and was not sized for the proper total dynamic head at the required rate of flow.
- Diatomaceous earth was not being separated from discharge water and was being improperly disposed of directly to the sanitary sewer.
- Chemicals were being improperly stored, labeled, contained and dispensed into the pools. Some chemicals were be-

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Pool Equipment Room: An Overview

To avoid problems such as those experienced by the Villa Portofino Homeowners Association, aquatic facilities should be inspected on a regular basis. Administrators should require that seasonal or quarterly reports be submitted on the condition of all pool equipment.

When inspecting the **pool equipment room,** check to see that the equipment is installed according to manufacturers' recommendations and follows good design practices. Make sure the equipment is sized properly in order to achieve the desired results. And, make sure the equipment is actually operating up to specifications. A thorough equipment room inspection should include determination of:

- **Effective circulation and movement of water**
- **Efficient filtration**
- **Proper and energy-efficient heater installation**
- **Safe chemical storage practices**

Uniform Circulation

Correct water levels must be maintained to allow for the removal of floating debris and for the continuous overflow of water into the **pool skimmers or gutters**. Typically, 50 percent to 80 percent of the water leaves from the surface of the pool. The remaining 20 percent to 50 percent of recirculated water is removed through the **main drains**. If the water level is permitted to drop below recommended levels, pool water will simply not be circulated properly.

Skimmer lines are under suction and are connected directly to the **recirculation pump**. However, pools with **gutters or perimeter overflow systems** are connected to the rest of the circulation system via a **surge chamber.**

Surge chambers, surge trenches or balancing tanks hold the displaced water of swimmers in reserve until needed by the recirculation system. Sizing of the chamber should be based on the anticipated displacement in gallons caused by the maximum bather load. As a minimum, it is recommended that the total surge capacity consist of one gallon for each square foot of pool surface area.

An **overflow line** should be installed in the surge chamber at an elevation ¼-inch above the desired swimming pool water level. Following equalization of the pool water level and surge chamber water level when the recirculation system is shut down, excess water will be discharged to waste.

A **modulating float** should be attached to a **butterfly valve** installed on the main drain line in the surge chamber. During normal operation, the float will close the valve 80 percent, allowing 20 percent of flow through the system to come from the main drain, and 80 percent from the gutters. If the water level in the surge chamber drops below its designed operating level, the modulating float valve will drop and begin to open the butterfly valve, thereby allowing more water to enter the recirculation system from the main drain. This will prevent damage to the system caused by inadequate water flow.

When the entire capacity of a pool has passed through the circulation system once, a pool is said to have been "**turned over**." Most state codes now require that commercial pools turn over four times per day or that the contents of the pool be recirculated once every six hours. Ninety-eight percent water clarity can be achieved with four daily turnovers of the water. This is assuming the filter is sized properly, clean and running 24 hours per day. Use the following formula to determine the flow rate:

No. of gallons of water
÷ Required turnover rate *(in minutes)*
= Minimum flow rate *(in gpm)*

Pipes must be of a diameter capable of carrying the required quantity of water so that the required turnover can be achieved. All piping, the filter and components that are part of the mechanical operating system should be **labeled, tagged or color-coded** as required by state code. **Operating manuals** should be obtained from the manufacturers for each piece of equipment, and **diagrams and operating instructions** should be posted for reference in the pump room.

A **flowmeter** should be installed properly on a straight length of effluent piping at operator eye level where both filtered and discharge water flow rates can be recorded. Flow meters measure flow rate — the number of gallons per minute of water passing a given point on the effluent recirculation line at any time.

Influent and effluent pressure gauges must be installed to indicate filter efficiency and the need to backwash. **Vacuum and pressure gauges** also should be installed on the suction and discharge sides of the centrifugal force pump.

In some states, a **pool dye test** must be conducted yearly in the presence of a health official to ensure uniform circulation patterns and the absence of dead spots. A regular dye test is a good idea, whether required by the state or not. Instructions are available from specialty chemical manufacturers that supply the tests.

Efficient Filtration

Pool water is filtered in order to be made safe and aesthetically pleasing for swimming. Small floating debris and suspended particulate matter are removed from the water during filtration. The water is less turbid, cleaner and clearer after filtering. Filters that utilize **sand, diatomaceous earth or pleated fabric cartridges** as filter media are commonly used on U.S. pools. Filtering capabilities vary tremendously among the different types of filters. For instance, sand filters are only capable of removing particles between 50 and 100 microns in size, while some diatomaceous earth filters are able to remove particles as small as 0.1 micron. For reference, a grain of salt is approximately 100 microns in size.

Total filter surface area must be adequate to meet recommended design flow rates. Regardless of the filter type selected or how often the water is circulated, clarity standards can be maintained only if the filter is sized properly. Undersized filters contribute to clarity and water quality problems because suspended particulate matter is not adequately removed.

The different types of pool filters have different design flow rates that should not be exceeded. The flow rates have been determined through testing by both the manufacturer and the National Sanitation Foundation. Speeding up the filtration rate will not cause the water to be better filtered, just better circulated.

Filter Type	Typical Flow Rates *(gpm per sq. ft. of filter surface for commercial pools)*
Rapid Sand	**3**
High Rate Sand	**15**
Vacuum Sand	**0.5**
Diatomaceous Earth (DE)	**2 - 2.5**
Regenerative DE	**1.6**
Cartridge	**0.375**

To determine required filter size: divide the volume of the pool by the required turnover time in minutes to find the minimum flow rate. Then divide flow rate by the design flow rate of the particular filter to determine the size of the filter in square feet.

For example, a 360,000-gallon pool with a required 6-hour turnover, will have a minimum required flow rate of 1,000 gallons per minute. A **high-rate sand filter** with a design flow rate of 15 gpm per square foot of filter surface area will require 66.6 square feet of filter area. A **diatomaceous earth filter** installed on the same pool will require 500 square feet of filter area, while 2,666 square feet of cartridge filter surface area is needed.

Contrary to popular belief, slightly dirty filters actually do a better job of filtering debris from the water than do clean filters. For this reason, filters should not be backwashed or cleaned more frequently than is necessary.

Proper Heater Installation

Today, swimming pools are heated using **direct-fired heaters, electric immersion elements, indirect fired heaters, heat pumps and solar heat collectors**. **Millivolt heaters** that use a continuous pilot light to ignite a burner are becoming less common. Millivolt heaters are being replaced by heaters that use **intermittent ignition systems**, also called spark ignition, electronic ignition or pilotless ignition, which require an electrical hook-up or line voltage. If a pool heater is to be used for temperature maintenance heating, rather than for intermittent heating, sizing is calculated using pool surface area.

Regardless of the type or brand of heater purchased, the heater installation must comply with the American Gas Association and Underwriters Laboratories (UL) codes and regulations and with ANSI standards and the National Fuel Gas Code for Gas-Fired Pool & Spa Heaters. The heater should be installed on a level, noncombustible base. Because oxygen is needed for combustion to occur and clearances are needed for maintenance purposes, adequate spacing must be left between the heater and the equipment room walls.

Safety devices should be installed on the heater to prevent improper operation and to eliminate the possibility of patrons being accidentally burned by excessively high water temperatures. A **high temperature limit switch, thermostat, flow switch, gas pressure regulator and check valves** between the filter and heater and between the heater and chemical injection equipment to prevent backflow of heated water should all be installed. A copper, stainless steel or CPVC **heat sink** should be installed between the heater and circulation piping. The heater should be bonded and grounded to avoid causing electrical shock.

Energy-efficient heaters help contain energy costs. Increase heater size by approximately 4 percent for each 1,000 feet in altitude. Erect **wind breaks** near outdoor heater installations and make sure the products of combustion are properly vented. Insulate pipes and install the heater close to the pool to minimize heat loss.

Store pool chemicals and other flammable materials safely away from the heater. Keep all open flames away from the fuel lines. The heater should be installed downstream from the circulation pump and filter, and upstream from chemical injection equipment on a correctly sized hydraulic system. Excessive velocity can erode heater components. Maintain proper water balance — unbalanced pool water running through the heater will cause calcification, corrosion, and early destruction of heater elements, as occurred at Villa Portofino.

Read the manufacturer's operations manual and complete all preventive maintenance on schedule.

Safe Chemical Storage

A separate room should be constructed next to the equipment room for the storage of chemicals and other hazardous materials used in maintaining the pool. The chemical room doors must be kept locked and accessible only to authorized personnel. Appropriate signage and warnings must be affixed to the outside of the chemical room doors.

Chemical storage cabinets and shelves, spill containment dikes, overpacks, chemical barrels and injection equipment should be installed. Adequate space must be provided for the safe storage of chlorine products, pH adjustment chemicals such as muriatic acid, carbon dioxide, caustic soda, or sodium carbonate; products used for total alkalinity adjustment including sodium bicarbonate and sodium bisulfate; calcium chloride for raising calcium hardness levels, algicides, flocculants and clarifiers, sequestering and chelating agents and other specialty chemicals.

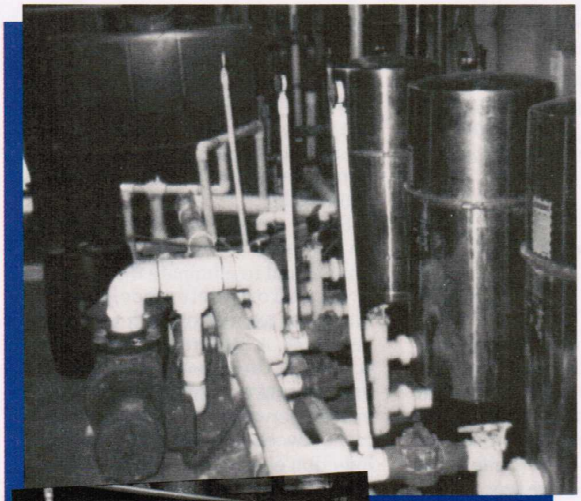
Ideally, the room should be at ground level, at the rear of the building and open to both the outside and to the equipment room. A loading dock or ramp should lead to the back door of the chemical room to aid in the delivery of chemicals. The room must be heated, well-ventilated, sloped to drain and constructed with one-hour fire-resistant walls. **Air monitoring equipment** and an **automatic fire sprinkler system** should be installed. A **material safety data sheet (MSDS) station, emergency eye wash and drench shower, and personal protective gear** should be stored in the equipment room, immediately outside the entrance to the chemical room.

Personal protective gear, such as **goggles, full-face shields, splash-guard aprons, Neoprene boots, respirators, disposable latex gloves, and one-way CPR pocket masks** must be purchased and staff members instructed in their proper use. Information on which pieces of personal protective gear are needed for each chemical used at the pool can be found on the respective MSDS information sheets.

All personnel operating or maintaining the pool or handling chemicals, not just the aquatic director, should be provided with the proper training.

MSDS sheets must be obtained from manufacturers, importers or distributors and posted for all chemicals stored on the premises. An MSDS station should be accessible to all employees who come into contact with chemicals while on duty. A master copy of the MSDS sheets, along with the Emergency Business Plan and records of employee training, should be kept in the general manager's or aquatic director's office.

— Dr. Alison Osinski



After repairs were finished, at left, the equipment room at the Villa Portofino community pool appeared neater and better organized than before, bottom left. The heater was replaced and some hazards were eliminated from the equipment room.

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ing fed directly into the pools, and empty chemical containers were not being disposed of properly.

• Chemical spill clean-up equipment, emergency eye wash, drench showers and personal protective gear for employees handling chemicals were not provided. MSDS stations had not been created. Non-compliance with hazardous materials regulations was evident.

Making Repairs

Once repair needs were prioritized, Kelli Fox kept the pool committee focused on what needed to be done. Char-

Test Equipment Suppliers' Guide

Following are suppliers of the types of equipment that can be used to troubleshoot problems with pool equipment. The list is intended as a resource to readers, not as an inclusive list to all suppliers.

Water Testing Equipment

BioGuard Pool and Spa Products *(Circle 75)*
Engineered Systems & Designs *(Circle 76)*
Environmental Test Systems *(Circle 77)*
HF Scientific *(Circle 78)*
Hach Co. *(Circle 79)*
Kruger & Eckels *(Circle 80)*
LaMotte Co. *(Circle 81)*
Morr Control *(Circle 82)*
Orbeco Systems *(Circle 83)*
Pal Products *(Circle 84)*
Presto-Tek Corp. *(Circle 85)*
Rainbow Plastics *(Circle 86)*
Taylor Technologies *(Circle 87)*
United Chemical *(Circle 88)*
Wallace & Tiernan *(Circle 89)*

Water Leak Detectors

American Leak Detection *(Circle 90)*
Anderson Manufacturing *(Circle 91)*
Find-A-Leak *(Circle 92)*
Heath Consultants *(Circle 93)*
Gems Sensors, div. IMO Inds., *(Circle 94)*
Lass Enterprises *(Circle 95)*
National Leak Detection *(Circle 96)*
Pal Products *(Circle 97)*
Retawmatic Corp. *(Circle 98)*
Wallace & Tiernan *(Circle 89)*

Chemical Leak Detectors

Capital Controls *(Circle 100)*
Rainbow Plastics *(Circle 86)*
Fischer & Porter *(Circle 102)*
Heath Consultants *(Circle 103)*
La-Co Industries *(Circle 105)*
J.C. Whitlam Mfg. *(Circle 104)*

Pressure Testers

Anderson Manufacturing *(Circle 106)*
Capital Controls *(Circle 101)*
Rainbow Plastics *(Circle 86)*

lotte Bell researched equipment and repair options, and presented a concise report to the Board, which included a cost analysis of equipment purchases and operating costs. She saw that the proper equipment was ordered and that the old equipment was removed from the equipment room as well as monitoring the daily progress of the work being done.

Because of her interest and past experience in supervising pool construction and repairs as a health and physical education director at YWCAs in Lansing, Mich., and Canton, Ohio, and as executive director of the YWCA of San Diego County, Calif., Mary McCarroll eventually became chair of the pool committee and took the lead in seeing that pool problems were solved.

"Homeowners were understanding during the period when the pool was without a heater and repairs were being made. Luckily, the problem occurred during the months of October through December, and pool usage is low during that time of year anyway," Bell said. Information on the repairs was addressed in the monthly association newsletter. Steps that were being taken to resolve the problems were explained, and members were asked to be patient.

Changes Implemented

To correct problems and prevent their recurrence, several changes were made. A new Teledyne Laars natural gas heater was installed by an experienced vendor.

The primary bactericide was switched from trichlor to sodium hypochlorite. Chemical injection equipment was relocated to the correct position and some circulation pipes were replaced.

Changes were made to improve the circulation pattern in the pool, eliminate dead spots and lessen the likelihood of uncontrolled black algae growth.

The pool water was drained to lessen the levels of total dissolved solids and cyanuric acid.

Ladder bumpers and anchors also were replaced.

The pool is now covered at night with a MacBall Industries insulating pool blanket to improve energy efficiency.

A ramp entrance was added for Americans with Disabilities Act compliance. The puddling and drainage problem near the clubhouse was corrected, and the pool deck was acid etched to lessen the likelihood of slip-and-fall accidents.

Preventive maintenance procedures were instituted. Creative Pools, a pool service company, was retained. The association feels the new service technicians are much more knowledgeable, keep good records, keep the board better informed of what is happening at the pool and are responsive to requests for assistance. Pool service has been increased to twice a week during the winter and three times a week during the summer, when use is heavier.

A Learning Experience

Asked if they had learned something about the operation of pools from the experience of having the Villa Portofino aquatic facilities evaluated, "Oh did I," Bell said. "Things I picked up from the report helped make me more aware. Now I can tell when someone is trying to pull something on us." McCarroll said she learned more about chemicals and hydraulic systems, and in particular how improper chemical application can destroy expensive pieces of pool equipment. Fox added, "You can get crazy trying to fix everything that needs fixing around a pool. The report helped us prioritize our needs. We found out what really needed to be done to bring the facility to within acceptable norms."

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